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1928

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POPULATION, FOOD SUPPLY, AND AMERICAN AGRICULTURE*

O. E. Baker
U. S. Department of Agriculture

THE three principal centers of the world's population are southeastern Asia, Europe, and North America. The extent of the arable area, including both land in crops and that which it is physically possible to use for crops, in these three regions is similar in magnitude—in each a billion and a half acres, more or less. But southeastern Asia and adjacent lands (India, Siam and Indo-China, the East Indies, China and Japan) contain about 900 million people, or nearly half the population of the world; whereas Europe has only about 500 million, little more than a fourth of the world total; and North America has less than 150 million people, or only a twelfth of the world total. As a consequence, there is fully three times as much potentially arable land per person in North America as in Europe and about six times as much per person as in southeastern Asia.

But the population of North America is increasing at a more rapid rate than the population of Europe or southeastern Asia. If Mexico and Central America, for which reliable data are not available, be excluded, the population of North America is increasing at the rate of about 1.5 per cent a year, of which about 1.1 per cent is by natural increase and 0.4 per cent is by immigration. The population of Europe, excluding the U. S. S. R. (Russia), for which data over a sufficient period are unavailable, is increasing only about half as fast, or perhaps 0.75 per cent a year; while the population of southeastern Asia as a whole probably is not increasing at present—in fact, owing to the troublesome times in China, it may be decreasing.

*An address before the joint session of the Farm Economic Association and the Rural Section of the American Sociological Society in Washington, December 29, 1927. Data on agricultural production revised and brought up to May 1, 1928.

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It is natural, therefore, that many people in Europe and a few in North America should see in southeastern Asia a vision of the future condition in their own continent and be troubled in mind, if not oppressed, by the thought of approaching population pressure, poverty, and weakness. Let us, therefore, consider the validity of this assumption that conditions in southeastern Asia with reference to population and agricultural production are prophetic of future conditions in North America. Although, as will appear later, we have grounds for optimism, we should also realize that our anticipations are based on a continuation of present trends and that, inasmuch as nothing in the modern world is certain except change, it is possible our calculations may prove to be mistaken.

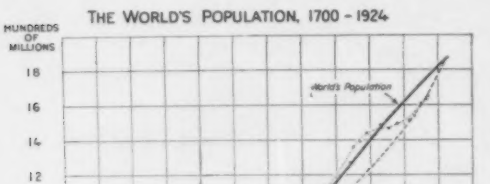


FIG. 1—The increase in the world's population since 1700, largely a result of the development of science and of economic organization. From G. H. Knibbs: The Mathematical Theory of Population, in Report on Australian Census of 1911, Vol. 1, Appendix A, Bureau of Census and Statistics, 1916.

Like all economic problems, this food problem has two sides, a demand side represented by population, and a supply side represented by agriculture. Let us consider the progress of population and then the progress of agriculture in each of the three continents after first noting the progress of population in the world as a whole.

THE PROGRESS OF POPULATION IN THE WORLD

The population of the world was about 500,000,000 in the year 1700, according to several estimates, 600,000,000 to 700,000,000 in the year 1800, about 1,000,000,000 in the year 1850, probably 1,500,000,000 by the year 1900, and is about 1,900,000,000 today. The population of the world has almost trebled since the year 1800 and prior to the World War was increasing at the rate of about 20 millions a year, which is an addition equivalent to the population of the United States every six years.

It appears, however, that a slackening in the rate of increase in the world's population is occurring (Fig. 1). This is owing primarily to the attainment of a stationary population in China a half century ago, if the official estimates may be accepted, and to a trend toward such a condition during the past two decades in India, which, however,

may prove transient. Moreover, as population has increased in Europe and North America during the past quarter century or more, the rate of increase has lessened somewhat proportionately, so that the actual increase in numbers is now more or less stationary—about four millions a year in Europe and nearly two millions in North America.

The Progress of Population in the Orient

The rapid expansion in the world's population during the last two or three centuries attained momentum first, it appears, in southeastern Asia. According to the successive returns of the Chinese census given in a recent interpretation, the population of China in 1750 was about 180,000,000; by the year 1800 it had risen to 300,000,000; and by 1850 the advance was practically over, and the population had reached a stationary stage at about 425,000,000 (Fig. 2).[1] In 1923 the Post Office estimate, based on returns from district magistrates, was 428,000,000 for the 18 provinces of China proper, and about 440,000,000 for the entire Republic. A recent study by Professor Willcox, of Cornell University, based on Ambassador Rockhill's data and the discovery of a copy of the 1910 census, supports this evidence of a rapid increase in the population of China during the eighteenth and first half of the nineteenth centuries but indicates that the Chinese Post Office estimate of population at present is too high by probably more than 100,000,000.[2] If the Rockhill-Willcox estimate of about 300,000,000 people at present in China be accepted, or 315,000,000 with Manchuria and Sinkiang, and it was doubtless no greater 75 years ago, it would appear that the increase of population in China between 1750 and 1850 was of a similar magnitude to that in the United States between 1820 and 1920. Whichever estimate of China's present population be accepted, it is interesting to note that the population of China in the year 1750, according to the official returns, was only about 25 millions greater than that which the United States will reach about the year 1950 and was increasing at about the same rate as the increase in the United States today.

In India it is not possible to trace the progress of population so far back; but between the first census in 1871 and the fifth in 1911 British India gained 60 million people, which is considerably more than the increase in the United States during these forty years. The 1921

[1] Chang-heng Chen: Changes in the Growth of China's Population in the Last 182 Years, *Chinese Econ. Journ.*, Vol. 1, 1927, pp. 59–69.

[2] Walter F. Willcox: The Population of China in 1910, *Journ. Amer. Statistical Assn.*, Vol. 23, 1928, pp. 18–30.

No positive statement as to the present status of China's population can be made. A study of selected rural groups made for "the normal year" of 1924–1925 suggests an increase, "which if continued would amount to a doubling of the population in every seventy years" (C. M. Chiao and J. Lossing Buck: The Composition and Growth of Rural Population Groups in China, *Chinese Econ. Journ.*, Vol. 2, 1928, pp. 219–235).

census, however, shows very little increase since 1911, either in British India or the native states. This is doubtless owing in large part to the epidemic of influenza in 1918, but it also appears probable that the population of India is approaching the saturation point under the present conditions of agricultural technique. However, the rapid expansion of manufacturing in India, as well as in other oriental countries, might extend the period of population increase for many years, provided food could be obtained to support the increase.

Agricultural Progress in the Orient

But in both India and China the increase in population has occurred without any marked advance in agricultural technique. The yield per acre of all the cereals is considerably lower in India than in the United States, and this is almost certainly true in China also, except for rice. There has been little development of dairying in either country, despite the fact that cattle have been raised for centuries; and, in general, the breeds of live stock are not as productive as in the United States. It appears probable that in both India and China the increase in population was accompanied by a lowering of the standard of living; although there is some evidence, notably the recent increasing per capita consumption of wheat, that the standard of living is rising in India at present.

Another surprising fact about China's agriculture (it is not true of India's agriculture) is that the proportion of the potentially arable land actually in crops is much smaller than in the United States. Of the 700 million acres, more or less, which it is physically possible to use for crops in China, only 180 to 200 million acres apparently were cultivated in 1918, according to official data,[3] or 25 to 30 per cent; whereas in the United States of the 975 million acres, more or less, which it is possible to use for crops, about 370 million acres, or nearly 40 per cent, were so used in 1919.

Probably two-thirds of the farmers of China are dependent on their own muscles for power, and apparently they can spade up or hoe up only two to four acres of land within the time permitted by the progress of the seasons. Experiments by men in the U. S. Department of Agriculture indicate that it takes 10 to 15 days to spade an acre. The cereals constitute about three-fourths of the total crop acreage in China. Two to four acres of grain does not yield sufficient food to support a family unless it is grown on productive land. There is a vast area of semiarid land in China, similar to the land in the western portions of our winter and spring wheat regions, but it cannot be utilized for lack of power. Whereas in western Kansas the

[3] "Statistical Tables of Agriculture and Commerce, 1918," issued by the Department of Agriculture and Commerce, Peking, 1921. See also O. E. Baker: Agriculture and the Future of China, *Foreign Affairs*, Vol. 6, April, 1928, pp. 483–497.

crop area per farm averages 200 acres, yielding 1200 to 1400 bushels of wheat or equivalent, in northwestern China the average is only four acres of crops per farm. Even to spade or hoe up this acreage requires 40 to 60 days. At seven bushels of wheat per acre, only 28 bushels would be raised on the four acres, which, after allowing for seed, is scarcely enough to keep life in two people for a year. So crop production in China is found mostly in the valleys and on river deltas, where much of the land can be irrigated and where three times as much wheat per acre can be raised as on the less moist or less fertile uplands, or five times as much rice per acre, if the climate permits.

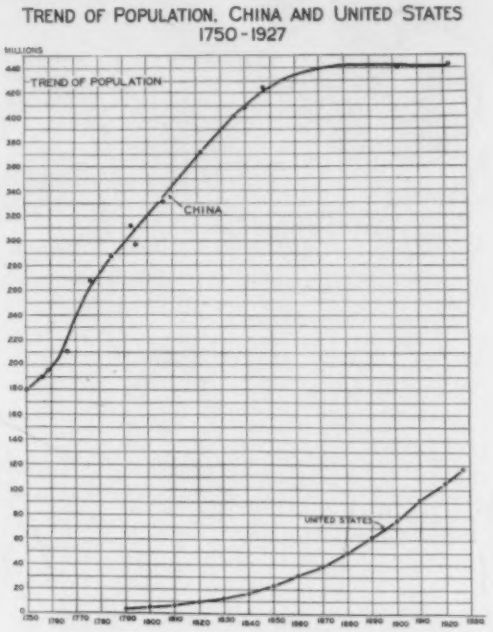


FIG. 2—Population trend in China and the United States compared. The data for China shown in the graph are from an article by Chang-heng Chen in the *Chinese Economic Journal*, January, 1927.

In Japan scientific technique and economic organization have supplemented the beneficent influence of a stable government, and as a consequence not only has population doubled in the past 50 years, but also the real income per capita has approximately doubled, according to a statement made to me at the Institute of Pacific Relations in Honolulu, July, 1927, by Dr. Nasu, Professor of Rural Economics in the University of Tokyo. However, despite the fact that Japanese farmers are even more dependent than Chinese on human muscle for power, fully three-fourths of their potentially arable land is in crops. This is owing partly to the humid climate, which provides sufficient moisture everywhere for high yields, and partly to the fact that Japanese farmers have available most of the assistance that modern science can afford. The agricultural experiment stations and other technical institutions are as highly developed in Japan as anywhere in the world. Partly as a consequence, the utilization of the agricultural resources has proceeded closer to the physical limit than elsewhere in the world probably, except Java; and Japan is facing the problem of population and food supply in all its stark severity.[4]

[4] See "The Pressure of Population in Japan," by J. E. Orchard, pp. 374–401 of this *Review*.

The Population Problem in the Orient

The Orient, therefore, does not seem to afford much help in finding a solution to the population problem. China might imitate Japan, further develop modern science and industry, and probably double its present population without diminishing the average individual's welfare, but this would only postpone for less than a century facing the fact of declining well-being. However, this development of modern science and industry in China is worth while promoting, and during the century a great change in social traditions and ideals might be achieved.

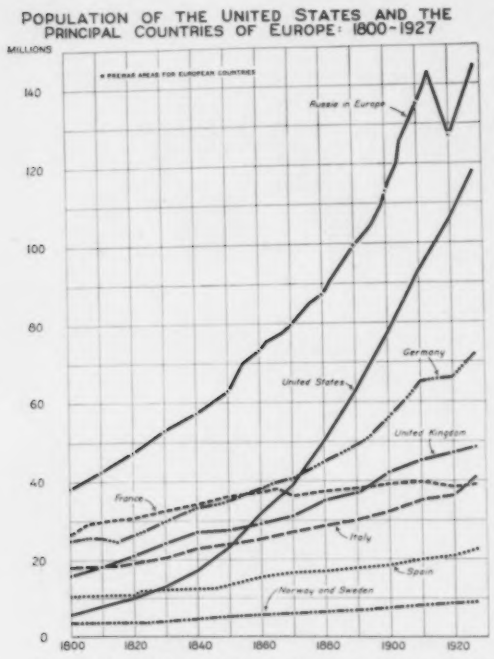


FIG. 3—Population trend in certain European countries and the United States compared. Data are from a graph in the United States Census 1910 (Vol. 1, p. 35), supplemented since 1910 by figures published in the Statesman's Yearbook.

From the standpoint of a permanent solution the depressing feature is that nowhere in the Orient does there seem to be an appreciable tendency toward voluntary restriction of population. Obviously, where there is no voluntary restriction there must be ultimately the involuntary restriction that Malthus described. Although in India the birth rate appears to be falling slightly, in Japan the birth rate was rising until last year and, apparently, is a third higher now than it was 50 years ago. However, the death rate has also increased so that the natural increase rate has risen from 7 per thousand to only 11 per thousand. For China no statistics are available, but it appears clear that the probably stationary population is owing to a high death rate, especially high among infants and the aged, and to wars, local famines, and occasional outbreaks of some pestilence.

The Progress of Population in Europe

Let us now turn to Europe, especially to northwestern Europe. In 1750 the population of Europe was, possibly, 170 millions, or less than that of China. By the year 1800 the population had increased

to about 200 millions, in 1850 it reached 280 millions, and by 1900 it was nearly 400 millions. During the past quarter century, despite the devastations of the World War, it has increased to 500 millions (Fig. 3).

This increase in population, unlike that in China and India, has been accomplished without a decrease in the standard of living; indeed, it appears probable that the per capita consumption of meat, of milk, of fruit, and of fresh vegetables, which are normally much more expensive than the cereal foods, has increased materially during the past century in most countries of western and central Europe, in some countries as much as 50 per cent.

How this extraordinary increase in both population and average well being was accomplished may be briefly noted with reference to England, though England, of course, was in advance of most of the Continent both in agricultural practice and in industrial development. In the year 1600 the population of England and Wales is thought to have been about 5,000,000; in 1700 about 5,500,000; in 1750 about 6,500,000; in 1800 about 8,900,000; whereas in 1901 it was 32,500,000 and today is over 39,000,000.

The Progress of Agriculture in Europe

We may review very briefly and in generalized fashion some of the important steps in the progress of production as a background to be kept in view when we note later the recent progress of agricultural production in both Europe and North America.

The increase of agricultural production in England and in most of northwestern Europe as well can be traced back, in large measure, to the spirit of individual inquiry, which led both to the Protestant Reformation and to the development of modern science. Even during the Middle Ages England afforded a haven for heretics from the Continent, many of whom were artisans. They established themselves usually in the towns and villages, where greater freedom to work and worship prevailed. As the towns grew the demand for food and raw materials grew also, and thus commercial agriculture arose. The profits derived from the sale of agricultural products promoted the development of private property in land, and this led to the Inclosure Acts. These Acts permitted the consolidation into a contiguous farm of many small parcels of land that had been operated previously only in unison with adjacent parcels farmed by other people and in accordance with tradition.[5]

[5] This medieval communal cultivation of land is still the common practice in the U. S. S. R. (Russia) and is an important cause of the low crop yields per acre. The coöperative use of tractors and harvesting machinery on these communal fields, however, is opening the way for other improvements in farm practice that may be as revolutionary as those in England during the eighteenth century and earlier.

With individual control of farm operations thus secured both by landlords and freemen, the adoption of improved methods of production became possible. Turnips were introduced from Flanders and were grown on the fallow of the medieval three-field system. This intertilled crop was more effectual than the fallow in controlling weeds, and it increased the crop area by a half. Moreover, the turnips and other root crops provided feed for more live stock, and these produced more manure. During the eighteenth century also clover was introduced, and this crop added both humus and nitrogen to the soil. Whereas in England wheat yields during the Middle Ages did not average over ten bushels per acre, by the year 1800 Arthur Young estimated the yields at 20 bushels. During the first half of the nineteenth century the use of lime and later of nitrate, phosphate, and potash fertilizers became common, partly as a result of the work of Liebig in Germany and of Lawes and Gilbert in England. Principally because of the use of animal manures, clover, and mineral fertilizers, wheat yields in England had reached 30 bushels per acre before 1880. Meanwhile, the breeds of farm animals were greatly improved. The amount of meat or milk produced per unit of feed consumed doubtless gradually increased, and at the same time the quality of the product was improved.

During this first half of the nineteenth century also steamship and railroad locomotive opened up a new epoch in the world's agriculture. Prior to the coming of these modern means of transportation, agriculture had been confined very largely to the originally forested lands. The forests supplied fuel and building material, and the ever-running streams that are found in forest areas provided drink for man and beast. Most of the grasslands of Europe and Asia, as well as of North America, were grazing grounds for nomads—Hungarians and Tatars in southeastern Europe, Manchus and Mongols in eastern Asia, Indians and later cattlemen and sheepmen in western North America. Lack of wood and water prevented the utilization of these grasslands for agriculture and the civilization dependent on it.

In addition to the development of steamships and railroads, two other great inventions help to explain the agricultural development of these grasslands and the extraordinary increase of population and wealth in Europe which has followed—the invention of well-drilling appliances and the development of grain-harvesting and threshing machinery. Wells gave water to the almost streamless plains, grain-harvesting machinery enabled one man to do the work of five, releasing the other four for labor in urban industries, while the railroads brought wood and coal to the settlers and provided cheap and rapid transportation to market for their grain and other products.

Thus it appears that the advance of science and the resultant development of industry in northwestern Europe, by affording large

markets for agricultural products and by providing means of transportation to those markets, has not only increased both the acreage and the acre yields of the crops in Europe but also has encouraged the expansion of crop production onto the grasslands of the world, until eastern Europe as well as western North America, even distant Argentina and far-away Australia and New Zealand, contribute to the food supply of western Europe. In the past this importation has been mostly from the former grasslands of the temperate zones, but in the future it must be more and more from the tropics.

Europe has much to teach North America with reference to a food supply for the increasing population, and it would appear that the limit of production has by no means been reached in Europe itself. The resources of science and agricultural technique are not exhausted.

These many means by which the food supply of western Europe has been increased are mentioned because some modern economists are prone to think only in the terms of the classical economists. When Malthus and Ricardo wrote their very influential treatises relating to population and the rent of land, the importance of nitrogen and phosphorus and potash in plant production was unknown, not a steamship rode the waves, not a railroad had been built, there was no agricultural machinery in our modern meaning of the word but only those farm implements that had been in common use since before the time of Christ. Milk production probably averaged not over 2000 pounds per cow, instead of 5000 pounds as in several countries of northwestern Europe and our best dairy states today. The point of diminishing returns was more or less fixed because farm practices were fixed, instead of being a point that receded with each advance in agricultural technique as is the case today. Those economists interpreted the economic conditions in their time; but it was a different time from that in which we live, though, perhaps, the difference is more in degree than in kind.

The Population Problem in Europe

In the trend of birth rates and death rates also Europe differs from Asia. In most countries of Europe a significant decline in the birth rate is in progress. Between the decades 1871–1880 and 1901–1910 the birth rate fell in Germany from 39 to 33 per thousand population, in Austria from 39 to 35, in Italy from 37 to 33, in Finland from 37 to 31, in Holland from 36 to 30, in England and Wales from 35 to 27, in Scandinavia from about 31 to 27, and in France from 25 to 20. In 1926 in England and Wales the birth rate was only 18 per thousand of population, dropping below that of France; and in Germany for several years it has been less than 20 per thousand, or about the same as in France; but, of course, owing to much lower death rates, the natural

increase in these countries was much larger than in France. In Italy the decline in the birth rate has been greater in the past twenty years than in the previous thirty years. In Catholic as well as Protestant countries of Europe the birth rate is falling. The death rates have been falling about as rapidly, so that the rate of natural increase has remained stationary or changed only slightly. But the death rates cannot keep falling continuously; and, if the birth rates continue to decline, several other countries as well as France will approach a stationary population in a few decades. If Europe can maintain its present rate of increase of both agricultural and industrial production for a half century, the future is full of hope.

The Progress of Population in North America

Nowhere has population increased at a more rapid rate during the past century and a half than in the United States. When our nation declared its independence 152 years ago, there were about 2,500,000 people scattered along the Atlantic Coast from Georgia to Maine. A quarter century later, by the year 1800, population had more than doubled; in a half century, by the year 1825, it had quadrupled; and by 1850 it was nine times as large as in 1775. Until the Civil War, Malthus' statement that, given plenty of food and normal freedom from disease, population tends to increase in geometrical ratio held true. But in the next quarter century a decline occurred in the rate of increase—a greater decline than can be explained by the influence of the Civil War. Population had not doubled by 1875, and between 1875 and 1900 it increased only 73 per cent. From 1900 to 1925 the increase in population was only 50 per cent, and it is now increasing at the arithmetical ratio of about 1,700,000 each year. This growth of the American nation from 2,500,000 to about 119,000,000 people during the period of slightly more than a century and a half since the Declaration of Independence, with the accompanying increase in wealth and culture, is unparalleled in human history.

But the rate of increase is decreasing. Both birth rates and death rates are falling. However, the death rate, which is now about 11.5 per thousand in the registration area, cannot go much lower, and may become higher. Dividing 1000 by 11.5 gives an average age of nearly 90 years, which is far beyond the present average or the average that may ever be expected. It is obvious that this "crude" death rate is not indicative of the "expectation of life," and is so low partly because of an abnormally large number of young people in our population. However, a five-year-old child may now expect to live to well past 60. Dublin and Lotka have shown that after the present natural increase rate in the United States, about ten per thousand, is corrected for the larger proportion of young people

in the population at present than there will be in the future, resulting from the fact that the population is increasing at a less rapid rate than in the past and that the large number of immigrants till recently were mostly young people, also because of the decreasing proportion of the population which is rural, the natural rate of increase would be reduced to one-half, or to about five per thousand.[6] Moreover, the trend in this rate almost certainly will be downward. It appears not improbable that the population of the United States will reach a stationary stage of 200 million near the year 2000 A. D.[7] Automobiles and other luxuries are only too successfully competing with children as objects worthy of sacrifice; and, perhaps, in more cases a proper sense of parental responsibility for the education of the children accomplishes the same result.

The trend of population in Canada, though the figures are much smaller, shows a similar but less regular rate of increase. The population in the year 1800 was about 400,000; by 1825 it had doubled; and in 1850 it was nearly six times as great as in 1800. From 1850 to 1875 it increased only about 35 per cent, and the increase was about the same percentage between 1875 and 1900. From 1900 to 1925, owing principally to the settlement of the Prairie Provinces, the increase was about 75 per cent. But between 1921 and 1926 the population in the Prairie Provinces increased only about one per cent a year, and the number of farms decreased.

Progress of Agricultural Production in the United States

Has agricultural production in the United States kept pace with this extraordinary increase in population, especially since the fertile western prairies have been occupied and settlement has pressed beyond onto the semiarid lands of the Great Plains region? It has, viewing the period as a whole. After falling behind during nearly two decades after the year 1900, agricultural production since the World War has increased more rapidly than population. And can agricultural production continue to keep pace with the increase of population until this population of 200,000,000 is reached? Available evidence indicates that it can, though probably a slight change in diet will occur, involving less meat and more dairy products and cereals.

Recently the Division of Land Economics, of the Bureau of Agricultural Economics, has been preparing an index of agricultural pro-

[6] Louis I. Dublin: The Statistician and the Population Problem, *Journ. Amer. Statistical Assn.*, Vol. 20 (N. S.), 1925, pp. 1–12.

[7] This is the estimate of Professors Pearl and Reed, of Johns Hopkins University, made several years ago (compare Figure 5 in O. E. Baker: Land Utilization in the United States: Geographical Aspects of the Problem, *Geogr. Rev.*, Vol. 13, 1923, pp. 1–26). Professor P. K. Whelpton, of the Scripps Foundation for Research in Population, Miami University, in discussing this paper noted that the recent studies made by this Foundation indicated that a stationary population of 175 to 180 millions would be reached several decades before the year 2000 A. D.

duction in an effort to understand the present anomalous agricultural situation and determine whether there is likely to be need of more crop land in the near future. The index consists of the annual amount of animal products (beef and veal, pork and lard, mutton and lamb, poultry and eggs, milk, wool and mohair), plus the production of that portion of some 28 crops which was not fed to live stock in the United States. The various items have been combined on the basis of the average farm price during the decade 1917–1926. An index of

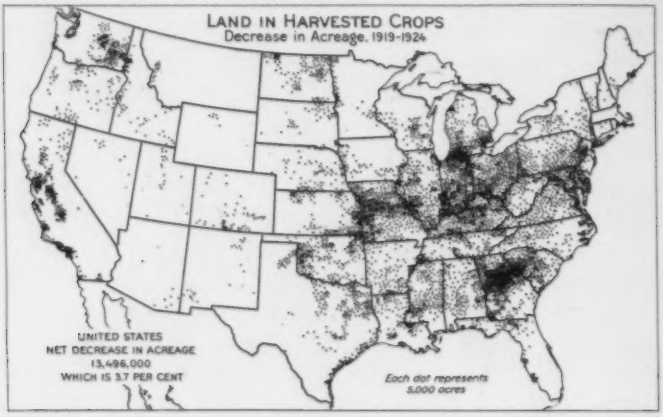


FIG. 4—The decrease in acreage of crops between 1919 and 1924 was general in most of the eastern, originally-forested portion of the United States, in general less fertile than the prairie and plains land and in parts too hilly to be well adapted to the use of modern farm machinery. With rising wages it has become increasingly difficult to farm some of these eastern lands profitably. Scale approximately 1:50,000,000. (Bureau of Agricultural Economics.)

consumption of agricultural products also is being compiled, but the work is not as far along as that on the production index.

It has proved possible to extend the production index only as far back as the year 1897 with a reasonable degree of confidence, because of lack of adequate data on animal products; but the index of crop production, the prices of agricultural commodities, and the volume of agricultural exports all indicate that agricultural production was increasing more rapidly than population after the Civil War and until near the beginning of the twentieth century.

AGRICULTURAL PRODUCTION SINCE 1900

The preliminary figures of this index indicate that the production of milk, of pork and lard, and of potatoes, fruits, and vegetables in the United States per capita of the total population was higher in the last five-year period, 1922–1926, than in the first five-year period, 1897–1901, or, except for potatoes, in any five-year period intervening.[8]

[8] Bulletins giving details will be published by the Department of Agriculture when the index data are in final form. These will be illustrated by graphs.

On the other hand, the per capita production of the following foods decreased; beef and veal combined (beef decreased and veal increased), mutton and lamb combined (mutton decreased and lamb increased), chickens and eggs combined (eggs only slightly), and, notably, wheat and corn used for human food.

With reference to animal products, the per capita production of milk, which was about an eighth greater in the period 1922–1926 than in 1897–1901, was balanced by the decrease in per capita production

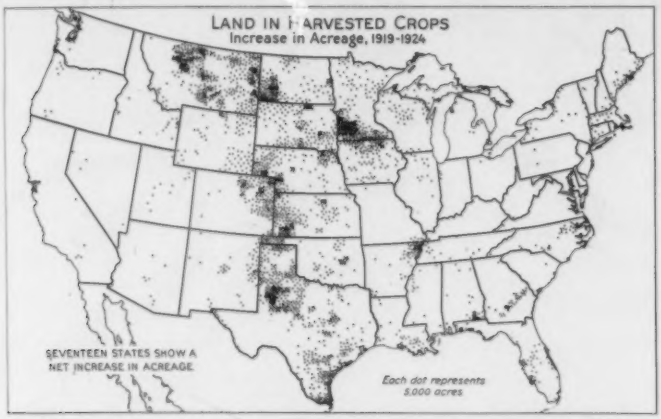

LAND IN HARVESTED CROPS
Increase in Acreage, 1919-1924
SEVENTEEN STATES SHOW A NET INCREASE IN ACREAGE
Each dot represents 5,000 acres

FIG. 5—The increase in crop acreage harvested in 1924, as compared with 1919, occurred mostly in the level, prairie portions of the United States, where, despite the subhumid to semiarid climate and low prices for farm products, the use of modern machinery, by increasing the area a man can cultivate, has made crop production profitable. (Bureau of Agricultural Economics.)

of meat and the slightly smaller decrease in per capita production of poultry and eggs. The per capita production of wool declined much more, indeed, the production during the period 1922–1926 averaged about the same as in 1897–1901; but meanwhile population increased 50 per cent. With reference to plant products, the per capita production of wheat, and also the aggregate of other cereal products used for human food, was nearly a third smaller in the later than in the earlier period. On the other hand, the per capita production of potatoes and likewise of other vegetables was nearly a fourth greater in the period 1922–1926 than in the period 1897–1901; and the per capita production of the fruits was apparently a fifth greater. The per capita production of cotton during the past decade has been much less than during the previous 15 years but nevertheless was higher in 1925 and 1926 than in any year since 1914. Combining the various agricultural products, it appears that production per capita during the period 1922–1926 was slightly less than during the period 1897–1901.

This comparison of the first and the last five-year period during the thirty years since 1897 is not adequate, indeed may be misleading, for between these two periods a notable depression in agricultural

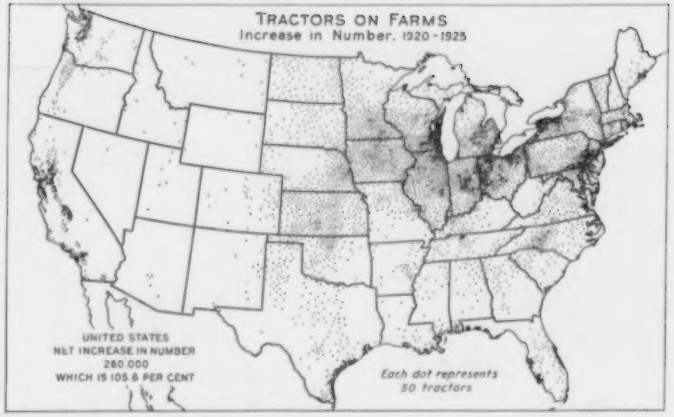


FIG. 6

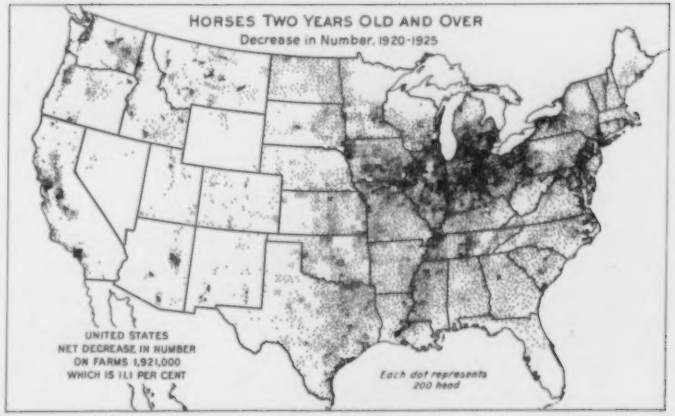


FIG. 7

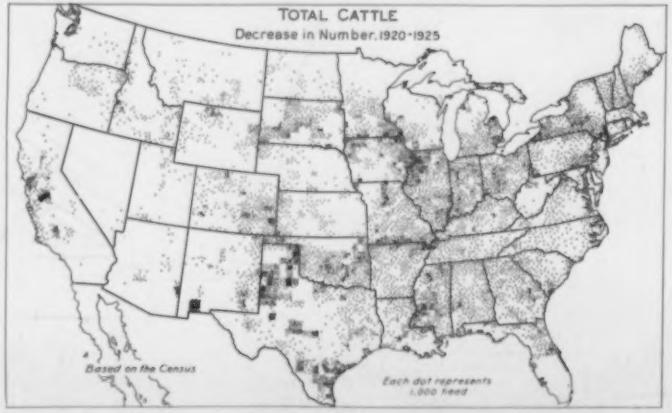


FIG. 8

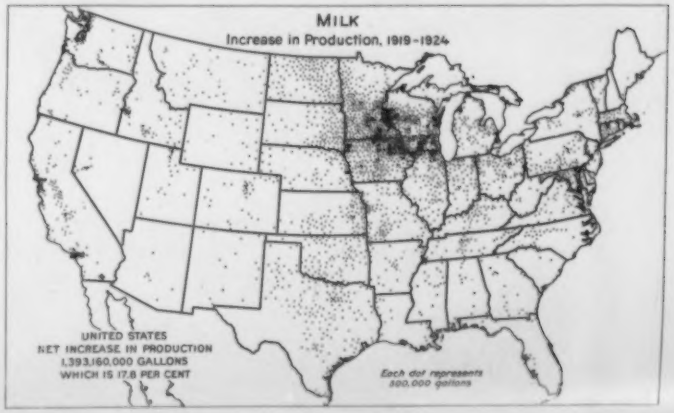
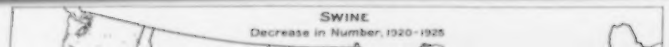
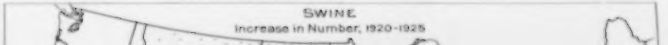


FIG. 9

FIGS. 6 and 7—Cartograms showing the relation between increase in tractors and decrease in horses (1920–1925). (Bureau of Agricultural Economics.)
FIGS. 8 and 9—Cartograms showing decrease in cattle (1920–1925) and increase in milk production (1919–1924). Despite the decrease in number of cattle in all the important dairy states except Kansas, Nebraska, North Dakota, and Montana, the production of milk was much greater in 1924 than in 1919. (Bureau of Agricultural Economics.)





FIGS. 8 and 9—Cartograms showing decrease in cattle (1920–1925) and increase in milk production (1919–1924). Except the Dakotas and Montana, all the important dairy states except Kansas, Nebraska, North Dakota, and Montana, the production of milk was much greater in 1924 than in 1919. (Bureau of Agricultural Economics.)

FIG. 10

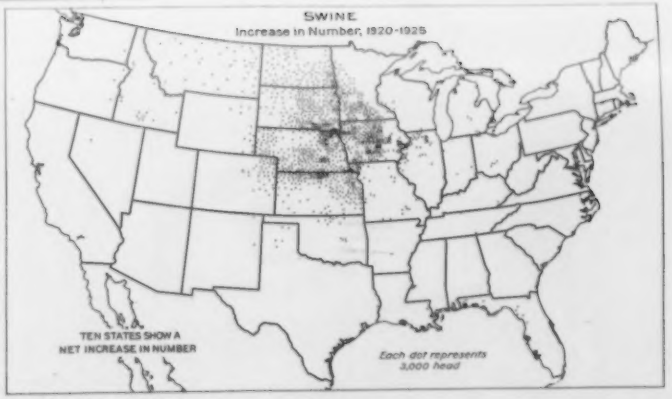


FIG. 11

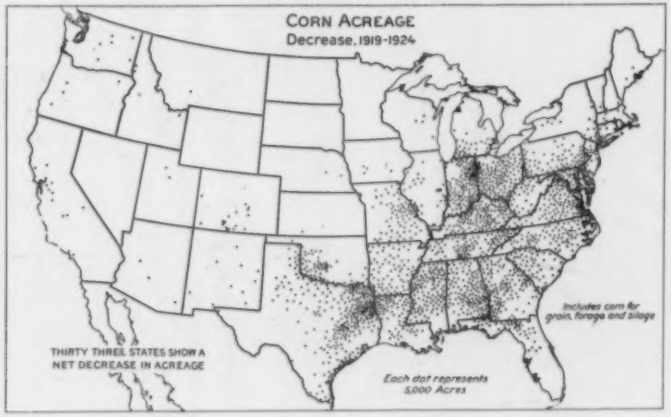


FIG. 12

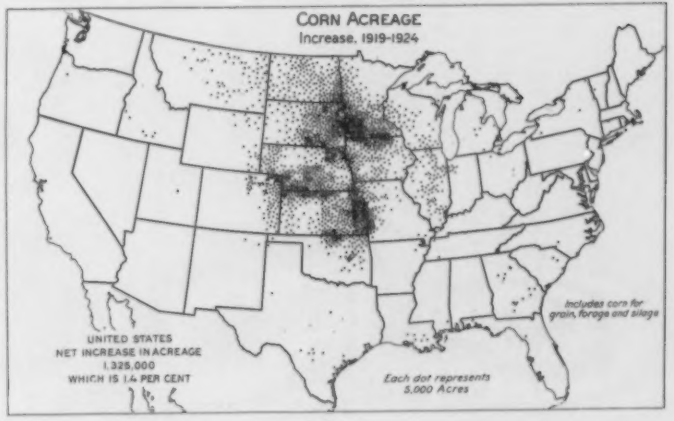


FIG. 13

FIGS. 10–13—Cartograms showing the relation between change in corn acreage (1919–1924) and numbers of swine (1920–1925). (Bureau of Agricultural Economics.)

production per capita occurred. During the period 1902–1906 agricultural production per capita was several per cent less than in the period 1897–1901; in the period 1907–1911 it was still less; in the period 1912–1916 it was about the same as in the preceding five-year period; and in the war and early post-war years 1917–1921 it declined to about nine-tenths of the per capita production in the period 1897–1901. Beginning with 1922 the increase in production has been rapid and almost uninterrupted. In the year 1926, for the first time since 1904, the average per capita production of agricultural commodities exceeded that during the period 1897–1901. Data are not yet available for 1927.

Agricultural Production Since the World War

It appears that the slower increase of agricultural production than of population after the year 1900, notably during the period 1909–1917, consisted, in large part, of a retarded increase in animal products, notably beef, mutton, and wool. There was also a relatively small production of cotton during the years 1915–1923. Even less increase in production of wheat and other cereals used for human food had occurred. Largely because of this slower increase of agricultural production than of population a rise in price of agricultural products occurred, which was further augmented by the demands of the world war, and, as a consequence, the application of scientific research to agriculture has been stimulated, improved farm practices have been widely adopted, and agricultural production has recently increased to such an extent that it has overtaken the increase of population. Even before this point was reached, the increasing production, in connection with decreasing exports of wheat and pork and increasing imports of sugar, was sufficient to produce the troublesome post-war surplus.

Agricultural production as a whole was over 14 per cent greater in the period 1922–1926 than in the period 1917–1921, whereas population increased less than nine per cent between the midyears of these two five-year periods; in other words, the increase of agricultural production was over 50 per cent greater than the increase of population.

More surprising than this rapid increase in production and resultant surplus, however, is the fact that this condition has developed despite a decreased, or at least stationary, acreage of crop land. The census of 1925 shows a decrease of about 13,000,000 acres in the area of crops harvested between 1919 and 1924 (Figs. 4 and 5), the first decrease shown by any census in our national history; while the average of the estimates of the Division of Crop and Livestock Estimates for the five-year period 1917–1921 as compared with 1922–1926 indicates a decrease of 1,000,000 acres. Moreover, the acreage of pasture in farms has decreased (but not total pasture), and the number

of horses and cattle and hogs has decreased notably; indeed, beef cattle are less numerous than at any time during the past 40 years, and there are about the same number of hogs in the United States as 40 years ago (Figs. 7, 8, 10, 11). Furthermore, the number of farms has decreased since the World War years, the farm population and number of farm laborers has decreased even more, and the average acre yield of the crops has increased only slightly.

This increase in agricultural production since the World War, despite a decrease in crop land and in number of live stock on farms, is owing primarily: (1) to the release for other uses of 15 to 20 million acres of crop land formerly required to feed the horses and mules which have been replaced by tractors and automobiles (Fig. 6); (2) to increasing efficiency of production, especially in the amount of milk and meat produced per unit of feed consumed; and (3) to a shift from the less productive classes of animals per unit of feed consumed toward the more productive (i. e. from beef cattle to dairy cattle and swine) and from the less productive crops per acre toward the more productive (i. e. less wheat and more corn in the North, less corn and more cotton in the South, and more vegetables and fruit, especially in California and Florida).

The Increase in Animal Products

About two-thirds of the increase in agricultural production is assignable to the increase of animal products. A study of available data indicates that there were about four per cent more dairy cows and heifers on farms January 1 in the period 1922–1926 than in the period 1917–1921 but that probably 20 per cent more milk was produced; that there were about five per cent fewer cattle but that six or seven per cent more beef and veal were slaughtered. However, after allowance is made for the depletion in number of beef cattle, there is no indication of a notable increase in production of beef and veal per animal on farms January 1. With hogs, however, as with dairy cows, the increase in production per head has been very large. There were about the same average number of hogs on farms January 1 in the period 1922–1926 as in the period 1917–1921, according to the estimates of the Bureau of Agricultural Economics, but the increase in pork and lard under Federal inspected slaughter was 25 per cent. Undoubtedly the inspected slaughter of hogs has constituted a larger proportion of the total slaughter in recent years, so that the increase in total production of pork and lard has been considerably less. It was about 20 per cent, according to the estimates of the Bureau of Animal Industry. There were somewhat fewer sheep on farms and ranges in the period 1922–1926 than in the period 1917–1921; nevertheless, over ten per cent more mutton and lamb was produced. Increase in production per animal is, of course, greater than increase in

production per unit of feed consumed; but, after allowance is made for the feed released by the decrease in horses and mules and for the shift from the less productive beef cattle toward the more productive dairy cattle and swine, it appears that the production of animal products in relation to feed consumed by the animals increased about seven per cent between these two five-year periods.

Many factors have contributed to this increase in production of animal products per unit of feed consumed. One of the most important has been the more rapid mechanization of agriculture and decrease in horses and mules in the Northern and Western States than in the Southern States. The large increase in feed available for meat and milk animals in the Corn Belt and in the states to the north and west has resulted in a much smaller decrease in cattle in these states than in the South and in a notable increase in number of hogs in most of these Northern and Western States as contrasted with a very great decrease in the South (Figs. 10–13). In general, the cattle and hogs are much more productive both per head and per unit of feed consumed in the North and West than in the South, and as the acre yields of the feed crops are also much higher there has resulted not only an increased production of meat and milk in the United States per unit of feed consumed, but also an even greater increase of production per acre of crop land.

Another, and perhaps almost as important, cause of the increase in animal products per unit of food consumed has been the slaughter at an earlier age. Younger animals make more rapid gains on the same amount of feed than older animals. Deaths from disease also have diminished, particularly in the case of hogs, owing to better sanitation and fewer losses from hog cholera. Better feeding, especially the greater use of legumes, has been another factor. But probably as important as anything has been the wider distribution of superior stock. High producing animals reduce the amount of feed as well as labor per unit of product. It requires only about 50 per cent more labor to care for a dairy cow giving 10,000 pounds of milk a year than to care for a cow giving 5000 pounds, and the amount of feed consumed by the more productive cow is only about 50 per cent greater, according to 100,000 cow-testing records compiled by the Bureau of Dairy Industry. However, it would be fairer to compare high producing herds with low producing herds, and when this is done it appears that the increased production per unit of feed will not exceed 25 per cent.

Probably no more significant development is occurring in American agriculture than this increasing efficiency of meat and milk animals in transforming feed into food. Of the 16 per cent increase in production of animal products between the five-year periods, 1917–1921 and 1922–1926, indicated by the estimates of the Department of Agriculture, about two-fifths is assignable to the feed released by the

decline in number of horses and mules, less than one-fifth to the shift from the less productive animals toward the more productive (from beef cattle toward dairy cattle and hogs), and fully two-fifths to the production by each class of animal of more human food per unit of feed consumed.[9]

Changes in Crop Production

Similar changes have occurred in crop production, but they are not of so great magnitude from the standpoint of economy in use of the land. Comparing the period 1917–1921 with that of 1922–1926, total crop production (including crops fed to live stock) increased about five per cent, while the aggregate acreage of the crops decreased slightly. However, only about one-third of this increase of five per cent in production per acre is owing to higher acre yields of the several crops, two-thirds being due to shifts from less productive to more productive crops per acre. In the Cotton Belt, for instance, except in Georgia and South Carolina, there has been a notable shift from corn to cotton, which yields a much higher value per acre. In the western Corn Belt and in the spring wheat region there has occurred a marked shift since the war from wheat to corn, which has a higher acre value (Fig. 13); and in California and Florida especially there has been a large increase in the acreage of fruits and vegetables, which have a very high value per acre.

Changes in Production per Man Since the War

As the quantity of labor engaged in agriculture decreased probably between two and six per cent, it appears that there was an increase of between seven and eleven per cent in crop production per unit of labor available. It is probable that the real increase in efficiency was much greater than this and that some labor formerly devoted to crop production has been required to produce the large increase in animal products. Recalling the net increase in agricultural production of over 14 per cent and estimating the decrease in labor on farms at four per cent, it appears that between the period 1917–1921 and the period 1922–1926 agricultural production increased about 18 per cent per unit of labor employed.

This probably unprecedented increase in labor efficiency is owing not only to more productive live stock and crops but also to the use of more power on farms. The number of horses and mules two years old and over on farms decreased from 21,873,000 on January 1, 1920, to 20,619,000 on January 1, 1925; but during these five years

[9] These proportions are based on preliminary estimates and are only approximate. The method of estimating will be described in a bulletin, now in preparation, on changes in land utilization since the World War.

the number of tractors on farms increased from 246,000 to 506,000. These 260,000 additional tractors had a rated tractive horse power of probably 3,000,000, to which perhaps 4,000,000 more horse power should be added for the increase in auto trucks and 2,000,000 horse power for the increase in stationary gas engines and electric motors on farms—in all, an increase of about 9,000,000 horse power of mechanical origin, not including any increase in automobiles.[10] Although this figure cannot be compared directly with the 1,250,000 decrease in horses and mules, it seems safe to say that in this five-year period there was several times as much increase in mechanical horse power on farms as there was decrease in animal horse power.

Looking Ahead

The substitution of mechanical for animal power on farms must continue for several years at least, for the number of horses and mules being raised on farms are sufficient to replace only about half the horses and mules that die annually. In addition, it should be recalled that cost-of-production surveys indicate that somewhat higher acre yields of the crops will be profitable even at present prices. The wider use of highly efficient farm animals probably would be even more profitable. If only 50 per cent more feed is consumed by cows giving 10,000 pounds of milk a year than by those giving 5000 pounds, or even if the increase is only 20 or 25 per cent when the entire herds are compared, the possibility of a large increase in production of milk without any increase in crop acreage or in yields per acre becomes apparent. A similar, though probably smaller, increase in efficiency of swine, of sheep, and of poultry is in progress and will doubtless continue for several years at least. These and many other improvements in agricultural production that are taking place indicate that crop acreage is likely to expand very slowly, perhaps not at all, in the next few years.

Looking forward a century, when it appears likely that our population will have become stationary, all the evidence available suggests that agricultural production can keep pace with the increase of people without much greater change in the character of the food supply than that which has occurred during the past century. Doubtless there will be some decrease in the per capita consumption of meat, especially beef, accompanied, probably, by a corresponding increase in consumption of milk, cereals, vegetables, and fruits; but this will be merely an adjustment to an urban manner of life by an increasing number of people, such as has been in progress for several decades.

This confidence, however, in the capacity of American agriculture

[10] C. D. Kinsman: An Appraisal of Power Used on Farms in the United States, *U. S. Dept. of Agric. Bull. No. 1348*, 1926, p. 6 (data used in graph). The figure on horse power developed by tractors has been reduced below that given in this bulletin; also the estimates for increase in stationary gas engines and electric motors on farms are smaller than those in the bulletin.

to increase the food supply as rapidly as population increases during the next century assumes that the advance of scientific knowledge, in experiment stations and elsewhere, and the spirit of progress among farmers will continue; also that at least the present degree of general intelligence among urban dwellers will be maintained. Should these bases of our civilization be impaired, agricultural progress might cease and population proliferate, as it has in the Orient, until poverty and ignorance overwhelmed our nation also.

In conclusion, may we note one other observation. Certainly so far as North America is concerned, and less certainly with reference to Europe, the progress of agricultural science and practice, in association with the decreasing birth rate, is removing much popular misapprehension with reference to the food supply as a cause of war. Such misapprehension is based on the reading of ancient rather than of modern history. "What achievement of our mechanical and industrial age is more distinctive than that it has relegated food, i. e. food as nourishment, to a subordinate place among the objects for which men labor."[11] Although this is not true of many peoples of the world, it is true of nearly all those who have applied science to agriculture and have entered the industrial age.

The future food supply of the American people seems assured, both with regard to quantity and variety, for at least a century, probably permanently; and, if the present trends in agricultural production and population in Europe continue, that continent, it would seem, need not be anxious, provided commerce is carried on with the rest of the world. The per capita consumption of food in the United States, and probably in Canada also, was never so high as at present, both with respect to quality and variety; and in Europe it is now approaching the unprecedented standards attained just before the World War. The prospect in the Orient is less promising, but the possibilities of increase in agricultural production are still great, notably in China. In Japan, the only Oriental country for which such information is available, the standard of living has risen greatly during the past fifty years, and it is to be hoped that the rest of the world will help rather than hinder Japan in its development of manufacturing, through which alone, apparently, it can continue to raise the standard of living of its people.

War offers no solution to the problems of increasing population but, instead, accentuates the difficulty. The solution, in the future as in the past, will be found in the progress of science and its application to agriculture, industry, and transportation and in the lowering birth rate which accompanies the scientific and humanitarian attitude toward life.

[11] Mark Jefferson: Looking Back at Malthus, *Geogr. Rev.*, Vol. 15, 1925, pp. 177–189; reference on p. 184.

THE PRESSURE OF POPULATION IN JAPAN*

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JAPAN labors with a perplexing problem. Her population is increasing at a rate so rapid that it threatens soon to pass beyond the productive capacity of the nation's soil and resources. Pressure of the population on subsistence is the basis of the present economic unrest within the country. Search for relief is the keynote of Japan's domestic and foreign politics.

Increase in population is not a new phenomenon in Japan. There has been a remarkable growth since the beginning of the modern era, but in the earlier years the increase was no cause for alarm. It was regarded with approval as an evidence of a strong nation, and only within recent months has it become a matter of concern. In 1925 the population of Japan, exclusive of possessions, totaled approximately 59,700,000, and for that year the net increase was some 875,000. The present interest in the population question may be said to date from the announcement of that startling increase by the Bureau of the Census in the summer of 1926. For 1926 the increase was over 900,000, and monthly figures now available indicate that for 1927 it was nearly one million.[1] Japan's population is growing in absolute numbers and at a rate of increase surpassed only by the phenomenal growth in the United States, a country with an area twenty times greater than the area of Japan and with a large annual influx of immigrants.

No other problem is commanding so close or so general attention in Japan today. It has become an effective issue in the making and unmaking of Cabinets. Former governments have extolled in patriotic utterances the rapid growth of the population as a sign of national strength. The present government is seeking the means of providing for the greater numbers. The Imperial Government has created a Commission for the Investigation of the Problems of Population and the Food Supply, while several similar bodies are engaged in other

* This paper is a part of a study on the development of manufacturing industries of Japan that is being made under the auspices of the Council for Research in the Social Sciences of Columbia University. It is based on an examination of Japanese records and on an investigation carried on by the author and by Dorothy J. Orchard in Japan in 1926.

[1] The principal statistical sources used in this paper are: *Résumé Statistique de l'Empire du Japon*, Vols. 40 and 41, Tokyo, 1926 and 1927; Statistics of Agriculture and Forestry (in Japanese); and of Agriculture and Commerce (in Japanese); the Japan Year Book, 1926; official announcements as published in contemporary numbers of the *Trans-Pacific*, Tokyo; correspondence with the Statistics Bureau of the Imperial Cabinet regarding population estimates.

studies related to productivity, natural resources, commerce and industry, and the like. Interest in the whole question of population has extended to the people. Scarcely a newspaper or a periodical appears anywhere in Japan that does not contain some mention of population and food supply.

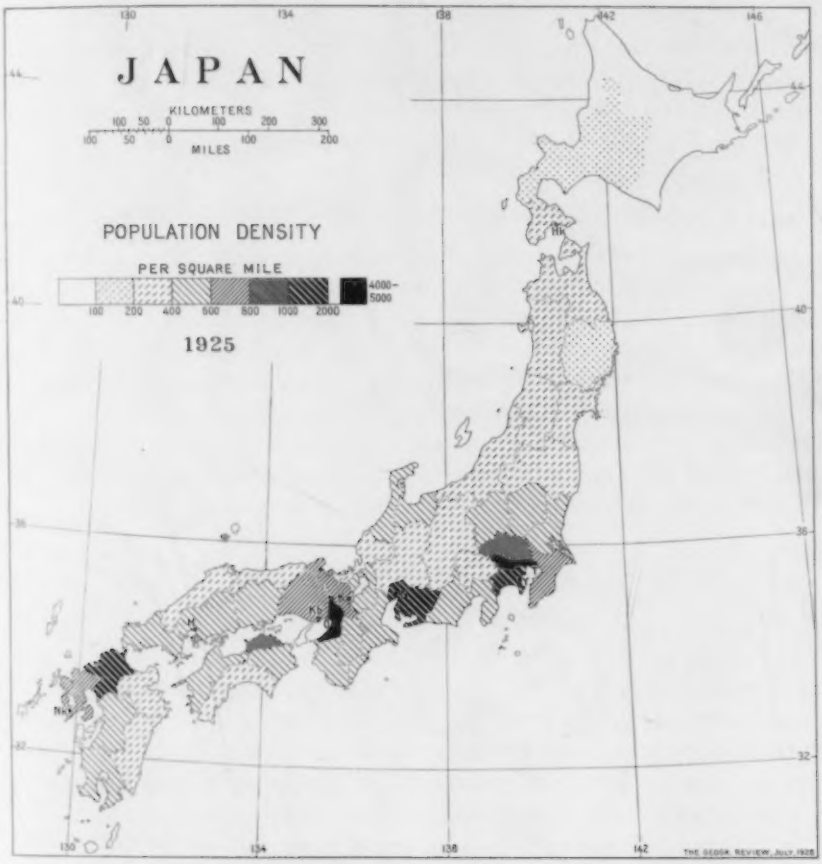


FIG. 1—Population density of Japan by prefectures, 1925. Scale approximately 1:14,500,000. The largest cities are indicated by initial letters: O, Osaka; T, Tokyo; N, Nagoya; K, Kyoto; Kb, Kobe; Y, Yokohama; H, Hiroshima; Nk, Nagasaki; Hk, Hakodate.

Such concern on the part of government and people can perhaps be best understood by expressing the population increase in terms of food. Rice is the staple food of Japan, and for many years the per capita consumption has been approximately 5½ bushels. To grow the five and a half million bushels of rice required for an annual population increase of one million about 145,000 acres of land must be added each year to the existing rice land. Such an area may seem small to Americans only one generation removed from the days of free land in

the Middle West, but for the past 18 years the annual increase in rice land in Japan has been only from 25,000 to 35,000 acres. To meet this new pressure on food supply, Japan must annually bring under cultivation an area of new land four to six times greater than the area she has been able to make arable in any past year by the expenditure of the most arduous labor. Japan has no frontier of empty lands easily available for the taking. If production is to be increased, cultivation must climb higher up the mountain sides, steeper slopes must be terraced, farm land must be pushed farther into the sea, swamps reclaimed, new irrigation systems built, or greater yields forced from the soil—always in the face of greater and greater obstacles.

The Historical Background of the Population Growth

The growth of population in Japan is apparently one of the results of the opening of the country to western influence. At least, it had its beginning with that event. Since 1860 the population has doubled. For perhaps two centuries before that date it had remained practically stationary (see Fig. 2). It is not easy to understand why the ending of Japanese seclusion should so directly affect the population growth. The usual and seemingly obvious explanation must be dismissed. The introduction of western hygiene and medical science has brought no decline in the death rate. It is higher now than it was in 1870.

The Static Population of the Tokugawa Period

When Commodore Perry led his four vessels into Uraga Bay in 1853, he unwittingly hastened the close of a great period in Japanese history, the period of the supremacy of the Tokugawa shoguns, a supremacy that had its beginning in the opening years of the seventeenth century.[2] From the twelfth century Japan had been torn by internal wars. The country was divided among great feudal barons or daimyos, and they were continually at war with one another. Under the Tokugawas the supremacy of the shogun was established. The feudal lords were subdued, and the civil wars came to an end. Very shortly the country entered on its period of seclusion. Foreigners were expelled, and contact with the rest of the world was limited to a closely supervised trade with the Dutch and Chinese. The Japanese were not allowed to leave the islands. With the removal of the likely causes of either internal or external disputes, there began an era of peace that was to continue without a break for two centuries and a half. No other nation has ever enjoyed so prolonged a freedom from both domestic and foreign warfare. It might seem to be a period

[2] The historical discussion that follows is based in part on "A History of Japan" by James Murdoch in three volumes: Vol. 1, 1910; Vol. 2, 1903; Vol. 3, 1926. For a more detailed account the reader is referred to that work, especially to Vol. 3.

favoring a great growth of population, but certainly for the last century and a half of the Tokugawa rule, the only years for which statistics are available, and probably for the entire period, the population was stationary.[3]

The first general census was taken in 1721, and it was decreed that beginning with 1726 there should be a census every six years. The data are admittedly incomplete but they serve as an index of the

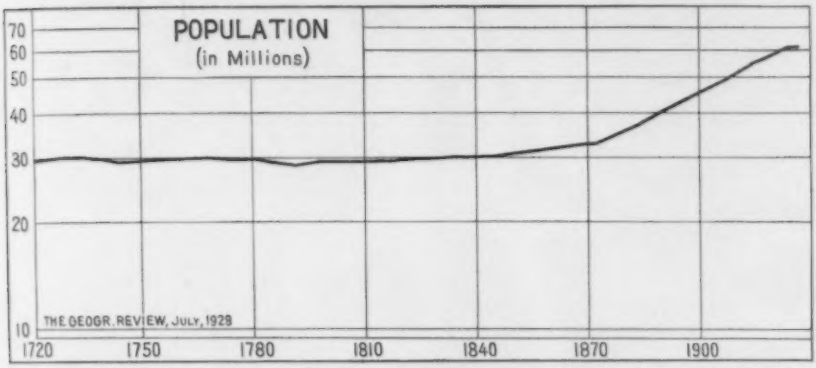


FIG. 2—Graph showing the contrast between the static condition of the population of Japan during the Tokugawa period and the rapid increase of modern times. (Graph on semi-logarithmic scale.)

population growth. In 1721 the registered population, without any correction for probable omissions, was a little over 26 millions. A century and a quarter later, in 1846, it was 26,900,000. The high and low points for the 125 years were separated by only two million, a marked contrast to the present annual increase of approximately one million.

FAMINES OF THE TOKUGAWA PERIOD

The Tokugawa era was a period of famines, and famines are a severer check on population than are wars. In the 150 years between 1690 and 1840 there were twenty-two famines in Japan, of which eleven were very destructive of life, one of the most serious occurring as late as 1837. The famines of China and India do not exceed in their horrors some of the Japanese famines in this period.

The famines were caused by flood and drought, frosts and typhoons, volcanic eruptions, and insect pests; but their severity and the great suffering and loss of life were due to the disorganization of the country and to the maladministration of the rulers. The Tokugawas had created a political empire, but the country was still economically a number of distinct states. Land transportation was little developed and limited to pack horses or to man-drawn vehicles over poor roads. Effective use was not made of the seacoasts and waterways; for, in order to

[3] Garrett Droppers: The Population of Japan in the Tokugawa Period, *Trans. Asiatic Soc. of Japan*, Vol. 22, 1894, pp. 253–284.

keep the Japanese within the country, sea-going vessels had been destroyed and the building of boats above 50 tons capacity, later increased to 100 tons, had been prohibited. The rivers of Japan are short and turbulent and not well adapted to traffic. Goods, if permitted by the daimyos to cross their boundaries, were subject to heavy dues. With the exception of the great cities, which drained the rest of the empire for their support, each district had to be practically self-sufficient. In the event of famine there was little possibility of assistance from more fortunate districts.

The country as a whole was in much the same situation. Japan's trade with the outside world was restricted to a few commodities of small bulk and high value. Rice could not be brought in from China or southeastern Asia to relieve a shortage. Japan was an isolated country made up of isolated units, and the country or the unit prospered or starved according to the local yield of the land.

Because of the division into isolated units there could be no regional specialization in production. Whatever the topography or the climate or the soil, food was necessarily the first consideration of agriculture. Though natural conditions might be much more suitable for tea or mulberry, neither of those crops provided subsistence in time of shortage, and there was no market for a surplus. Their production was not important even though the shogunate had exempted from taxation lands so planted.

The caste system that flourished under the Tokugawas, though borrowed from China at a much earlier period, reflected the local nature of production. The all-important personage in the economy of the people was the farmer, for from him came food and all wealth. To him was assigned a position high in the social scale immediately beneath the warrior class—the daimyos and samurai. The merchant received scant recognition. Trade was insignificant, and he seemed to contribute little. In times of famine he might even become the oppressor of the people, for he sometimes held back rice in order to secure higher prices. His was the lowest class, beneath the artisans and above only the outcasts.

Poor Administration of the Country

Economic disorganization of the country was not alone responsible for the severity of the famines. Even if transport had been easily available, there would have been no reserves in most of this period to send to the stricken areas. Some of the shoguns made provision for the storage of rice in the plentiful years against the coming of calamity; and Yoshimune, the eighth shogun, was able to save many lives during the famine of 1732 by sending rice from his granaries along the Sumida River in Tokyo to Kyushu and Shikoku. But later

shoguns gave little attention to the welfare of their people. The stores of rice were dissipated by corruption or drawn upon to pay feudal dues, and very shortly the stocks built by Yoshimune were depleted and never replenished. Japan during most of the Tokugawa period suffered from poor government centered in the corrupt and extravagant court of the shogun.

Low Birth Rate of Tokugawa Period

Not only was the death rate very high during the Tokugawa period, but the birth rate was kept low by a number of checks. Although there was extravagance and profligacy at the courts of shogun and emperor, the upper classes, or samurai, seem to have lived for the most part frugal, stoical lives. Their income, fixed in rice, fluctuated in value with fluctuations in price. They engaged in no productive occupation and could not add to their incomes. They lived as parasites on the labor of the farmers, giving in return no measure of service, for in a land of peace their swords were no longer needed. Their profession was a closed one, since they were an obsolete heritage of the previous period of war, and new samurai were rarely created. By law the number of family heads was limited, and the first son inherited his father's position as well as his income and property. Among the samurai, to have more than three children was degrading. They rarely married before the age of thirty, but earlier marriages were usual among the common people.

Abortion and infanticide were practiced in all levels of society.[4] It is said that in the Ekoin Temple near the end of the Ryogoku Bridge in the Honjo district of Tokyo there is a tombstone which bears on one side in Chinese characters the inscription "Embryos' Tomb" and on the other the following: "This tombstone is built on the 28th day of the Fifth Month of the Fifth Year of Kansei [1793] for the spirits of about 10,000 embryos buried here." The Japanese word for infanticide is "mabiki," the same word used to describe the thinning of a field of vegetables.[5] Similar to the practice of infanticide was that of doing away with the aged. Near the city of Nagano there stands in the midst of the magnificent rice terraces a large rock where, according to local tradition, the old women of the valley were exposed to die after they had passed beyond their years of usefulness.

The Hampering Restrictions of Feudalism

These positive checks on the population were due for the most part to the scarcity of the food supply. Japan was dependent almost

[4] K. Yamamoto: Birth Control in Old Japan, *Trans-Pacific*, April 2, 1927, Tokyo.

[5] Eijiro Honjo: The Agrarian Problem in the Tokugawa Régime, *Kyoto Univ. Econ. Rev.*, Vol. 1, 1926, pp. 75–93.

entirely upon agriculture, but the mountainous character of the islands made cultivation difficult. The arable area during the Tokugawa era certainly did not exceed 13 per cent of the whole and for much of the period it was probably nearer to 8 per cent.[6] The productive capacity of the land was less hampered, however, by the limitations of nature than it was by the restricting regulations of the feudal system.

All classes were surrounded and bound down by the most exacting rules. The rigid caste system arranged the population in water-tight compartments, and the son had little choice but to follow in the footsteps of the father; and in professions where there was no expansion there was always overcrowding. To prevent the growth of a class of large landed proprietors, a possible source of danger to the shoguns, it was decreed that the peasants could not sell their lands.[7] Though the law probably had the desired effect, it also kept good land in the hands of indifferent cultivators. It even resulted in the abandonment of land by some owners who dared to ignore the laws and seek other occupations. The peasant could not change the character of the use of his land. He could not reclaim new land without first receiving permission from the head of his village.[8] Taxes were heavy, and there was little stimulus to a greater production since a larger output usually led to heavier exactions by the tax gatherer.

The feudal laws and the restrictions on internal and external trade also discouraged the growth of manufacturing. Manufacturing was still in the handicraft, household stage; but it could have been developed to yield a considerable product for exchange. As it was, industry was restricted to supplying the needs of the immediate locality, and even that limited market was greatly reduced by the many sumptuary laws. They forbade the wearing of silk except by the highest classes. They regulated the size and construction of the dwellings, the number of presents that might be given at weddings and births. Manufacturing was as much on a subsistence level as was agriculture.

Growth of Population with Opening of Japan

Such was the Japan of the end of the Tokugawa era—a country static in population, stagnant in agriculture and in industry. Contrary to the beliefs of most economists the arrested growth was not due

[6] James Murdoch: A History of Japan, Vol. 3, The Tokugawa Epoch, 1652–1868, London, 1926, p. 353. Also Kan-ichi Asakawa: Notes on Village Government in Japan After 1600, II, *Journ. Amer. Oriental Soc.*, Vol. 31, 1911, pp. 151–216; reference on p. 159.

[7] Japanese Feudal Laws (a translation of "Edict in 100 Articles" of text given in Kodai-Hoten), *Trans. Asiatic Soc. of Japan*, Vol. 41, Part V, 1913. Also Asakawa, *op. cit.* Some Japanese authorities seem to believe that the purpose of this regulation was to protect the peasants from the loss of their lands. Whatever its purpose the effect on production would be much the same.

[8] D. B. Simmons and J. H. Wigmore: Notes on Land Tenure and Local Institutions in Old Japan, *Trans. Asiatic Soc. of Japan*, Vol. 19, 1891, pp. 37–270. Also Asakawa, *op. cit.*

to exhaustion of agricultural possibilities. The point of population saturation had not been reached, but the country had developed to the utmost limits of the inelastic economic and political system of the feudal age. Further expansion was possible only with the bursting and casting off of the constricting shell. The opening of Japan to the West accomplished just that.

Almost immediately upon the defeat of the shogun and the restoration of the emperor to power increase in population began. The first estimate of the population since the restoration of the emperor was made in 1872. It was an estimate more accurate and more complete than the censuses under the shoguns, and to be comparable the returns of the Tokugawa period must be corrected by adding approximately three million to allow for the classes not counted. In 1872 the population was 33 million, or an increase over 1850 of perhaps 3 million. The more rapid increase began in 1875. In the next five years, though it was the period of the Satsuma rebellion, there was an increase of 2 million, or at the rate of 12.43 per thousand per year. By 1889 the total was 40 million, and twenty years later the 50-million mark was passed. Since 1910, with the exception of the two years 1918 and 1919, the rate of increase has been from 12 to 15 per thousand per year, and the present absolute increase is approximately a million.

No Decline in Death Rate

It has already been observed that the great increase in population is not due to a lowering of the death rate through the introduction of Occidental sanitation and science. Famine has disappeared as a cause of death, but the present death rate is apparently no lower than it was in the non-famine years of the Tokugawa era. In 1873 the death rate was 19.6 per thousand. Fifty years later it was 22.8 per thousand. During the half century it ranged most of the time between 19 and 22 per thousand with a low point of 16.6 per thousand in 1880 and a high point of 26.8 in 1918.

Japan has never been subject to great plagues save that since the coming of the foreigner cholera has occurred in some of the ports; but there have always been present a great many intestinal diseases due probably to the diet and to the use of human excreta as manure for the rice fields. Neither the diet nor the method of fertilizing the land has changed with westernization. If anything, the chances of intestinal diseases have been increased, for with a greater population there are greater chances of contamination. At present, diseases of the stomach and intestines are the most common causes of death.

The growth of industry and the urbanization of the population have caused in some countries an increase in the death rate. Most of the Japanese cities have developed since 1875, and now some 35 per

cent of the population live in communities of over 10,000. In 1889 only 15 per cent were urban.[9] The large cities, however, have a death rate lower than the average for all of Japan or for the rural areas. In 1925, for example, the death rate for Japan was 20.3 per thousand. For Tokyo it was 16.6 and for Osaka 19 per thousand. The purely agricultural prefectures of Toyama and Ishikawa had death rates around 25 per thousand.[10]

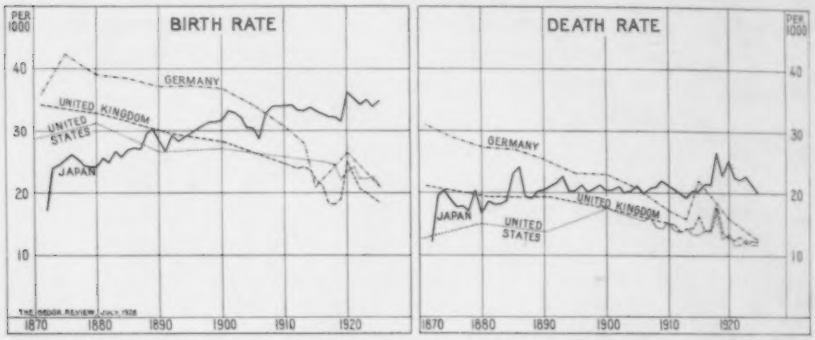


FIG. 3—Comparison of the birth rates and death rates of Japan and certain Occidental countries. Data from official sources.

INCREASE IN THE BIRTH RATE

The cause of the growth of population in Japan since the beginning of the Meiji era is to be found in a birth rate that now exceeds the birth rate of any of the other great nations, with the possible exception of Russia. In 1872 the birth rate was 17 per thousand; in 1924 it was almost double that rate, or 33.8. The vital statistics of Japan present some rather marked contrasts with the statistics of the leading western nations (see Fig. 3). In Japan alone has the curve of birth rates shown a general rising tendency; in the United States, the United Kingdom, and Germany during the past fifty years it has steadily declined. Despite their declining birth rate, however, the population of the three western nations has increased because their death rate has also declined. Japan has accomplished her phenomenal increase not by the conservation of life but through an amazing fertility. The high birth rate has in fact contributed to the death rate, for in 1924 almost 40 per cent of the deaths occurred in children under four years of age.

The great increase in the birth rate was due, in part, to the change in the attitude of the nation towards the size of the family that occurred with the opening to the West. The Japanese leaders decided that a large population—man power—was essential for defense

[9] K. Yamamoto: Birth Control in Old Japan, Statement by Professor Ueda of Commercial College of Tokyo, *Trans-Pacific*, April 2, 1927.

[10] *Kampo*, September 1, 1926 (Official Bulletin of Japanese Government, in Japanese).

and for aggression if that should ever become necessary. There began an active propaganda to establish the idea that a large family was the patriotic duty of every loyal subject of the emperor and that an increasing population was a sign of national strength. So successful has the propaganda been and so firmly has the idea of an increasing population been fixed in the Japanese mind that to one not familiar with the nation's history before 1850 it might seem to be an integral part of the Japanese religion, a heritage of former centuries. To all excepting the most liberal-minded the large family has become a sacred institution, and any attack upon it is almost as profane as an attack upon the emperor himself.

Increase in Food Supply through Trade and Improved Land Utilization

This philosophy of the large family, no matter how vigorously disseminated, could probably have never obtained so firm a hold on popular thinking if, at the same time, there had not been made available more abundant means of feeding the greater numbers. Rapidly as the population has grown, increase of the food supply has more than kept pace with it. During the modern period there has been no recurrence of famine and, according to Professor Morimoto, an economist of the Hokkaido Imperial University and an authority on the Japanese standard of living, the standard has advanced materially during the last half a century. As evidence he cites the increase in the per capita consumption of meat and sugar. The consumption of rice has also increased. In 1924 the consumption was 1.126 koku per capita as compared with 1.013 koku for 1835, an increase of about 11 per cent.[11] Almost half of this increase has occurred since 1912.

The resumption of trade with the outside world made it possible to import food, especially rice, in case of a national shortage; but Japan has had to place little dependence on the importation of food. At present not more than ten per cent of the food consumed within the country is imported.[12] The great increase in food supply of the country has come for the most part through internal reorganization.

The West contributed more rapid means of transportation, and the task to which the new government first addressed itself most vigorously was the building of railroads and roads to connect all parts of the country. Japan under the Tokugawas had become a political empire. In the Meiji era the unification was completed, and the country became an economic empire.

[11] The koku equals 4.96 bushels. The figure for 1835 is based upon an estimate, officially accepted, of the total production of rice for that year as 30,400,000 koku (Asakawa, *op. cit.*, p. 159) and upon an estimate of the population at 30,000,000, based on Droppers' correction (*op. cit.*).

[12] E. C. Grey: The Food Problem in Japan, *Trans-Pacific*, July 30, 1927, investigating food problems in Japan for the League of Nations.

Trade, both internal and external, developed markets for surplus products, and agricultural specialization became possible. Rice continued to be the major crop and to occupy the choice land; but crops that could be produced only with difficulty gave way to others more suited to local conditions. Under the Tokugawas cotton was widely grown, especially in the southern and northeastern parts; now very little is grown. Ever since 1899, the year for which figures are available, there has been a tremendous shift and decline in the districts producing cotton. Osaka, which then led all the other prefectures with a production of 929,000 kwan, now produces less than 7000 kwan (the kwan equals 8.27 pounds avoirdupois). Cotton can be brought in from India or from America, and the land can be used for production of food (see Fig. 4).

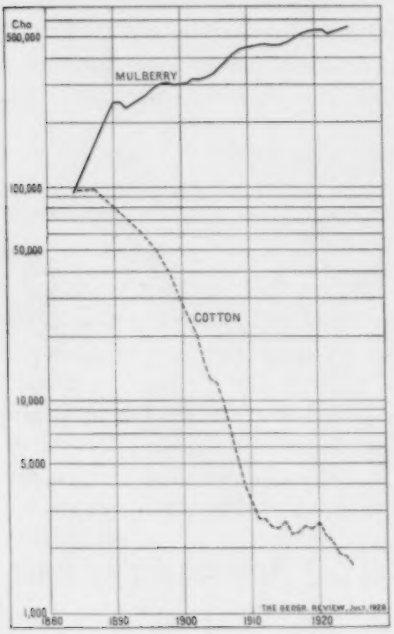


FIG. 4—Specialization has crowded out the cultivation of cotton and increased the area under mulberry in Japan. (Graph on semi-logarithmic scale.)

In Nagano, a prefecture of narrow valleys and steep mountain slopes in the central highland mass, much new land has been brought into cultivation in the last fifty years. During the feudal period all of the flat bottom land and the lower slopes had been put into rice, but the upper slopes were used only for the production of the mulberry required for a silk industry supplying local needs. One of the early railroads penetrated the valleys of Nagano and provided a means for carrying the raw silk to the seacoast where contact with the western world had already created an insistent market. The area in mulberry increased rapidly; and Nagano, a prefecture without much level land, is now highly prosperous. In 1925 the area in mulberry was almost three times as great as the area so used in 1891, and the output of raw silk had increased more than tenfold.

In Shizuoka, another mountainous prefecture, the production of tea has increased threefold since 1890. In all of Japan between 1905 and 1923 the increase in land under dry cultivation (largely mulberry and tea) was 19.2 per cent, and the increase under wet cultivation (rice) was only 8.2 per cent. In Chiba prefecture, east of Tokyo, much land formerly in soy beans is now in rice and beans are imported from Manchuria for the soy breweries.

Increase in Production through Breaking Down of Feudalism

Another influence that cannot be emphasized too strongly in its encouragement of increased production was the breaking down of the feudal system and the removal of its shackles. The sale of farm land was no longer prohibited. The good agricultural fields tended to pass into the possession of the good cultivators, and the poor culti-

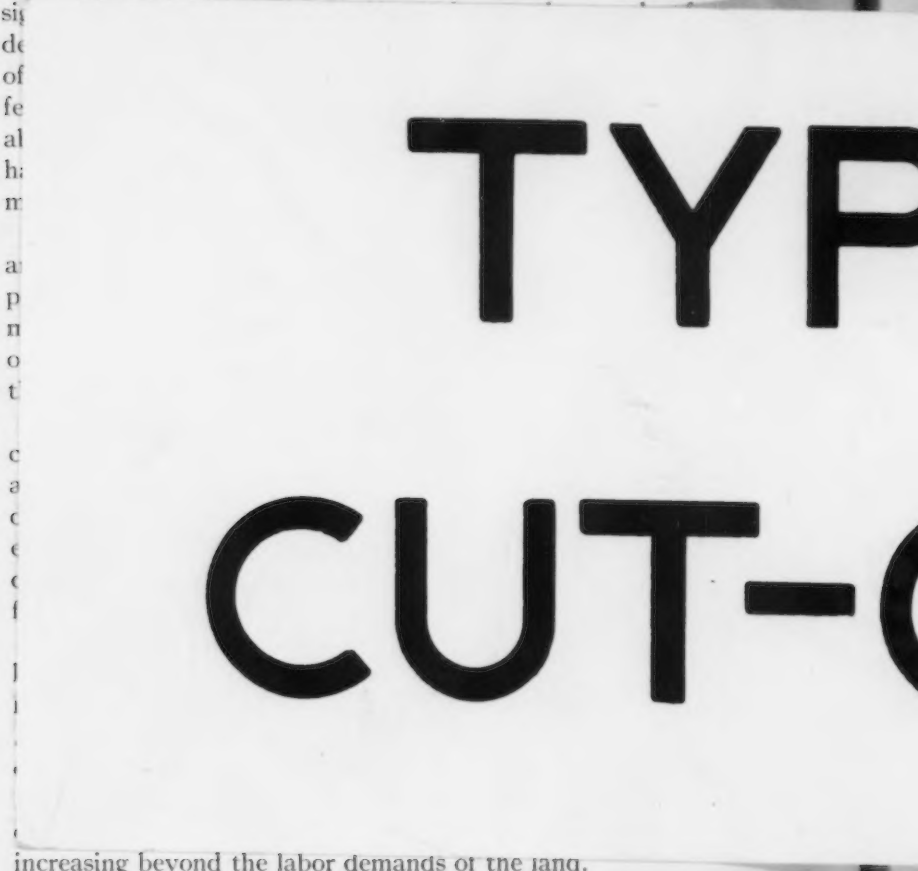
Fig. 5—For local transport man is still the beast of burden. A cartload of tea in a Shizuoka street.

vators gravitated to the poor land. Use of land was no longer restricted, and reclamation of new ground was encouraged.

During the Meiji era the production of rice has increased at almost exactly the same rate as the population (see Fig. 9). Statistics for the earlier years are not available, but in 1880 the output of rice for the population of 36 million was 31 million koku, or .87 koku per capita. In 1927 the population had increased to a little over 61 million and the rice yield to about 61.5 million koku, or 1 koku per capita. The increase in output has been due in part to the reclamation of new lands and to the increase of the area of arable land planted in rice, but most of it must be attributed to intensification of cultivation and higher yields. The per capita area in rice has actually shown a decrease from .071 cho in 1880 to .050 cho (a cho equals 2.45 acres) in 1926. For the five years from 1880 to 1884 the average yield per cho was 11.56 koku, and for a similar period ending with 1926 the average was 18.33 koku.

It should be remembered that this great increase in production has been accomplished in a country that for over two centuries was on

the very margin of subsistence, with famine following famine. It cannot be explained by the importation of any revolutionary agricultural methods from the west, for rice is still cultivated by hand with the same tools and fertilized in very much the same manner as for centuries. It cannot be explained by any improvement in the environment. Soil, area, topography, and climate all remain as they were. The only



increasing beyond the labor demands of the land.

The Search for a Solution

Such are the influences that have produced the Japan of today, a country with a population increasing so rapidly that her leaders are viewing the future with concern. An examination of the area of Japan gives substantial grounds for their fears. Japan is a group of mountainous islands. It is almost impossible to travel anywhere out of sight of a mountain range. At present only 15.6 per cent of the total area is arable, a more limited area than in any other great nation. If only the arable part of Japan is considered, the population density is

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FIG. 7

FIG. 6—Drying rice along the boundary ridges between the fields.

FIG. 7—Threshing wheat in a farmyard near Osaka. The grain is spread carefully on mats so that none will be lost.

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the very margin of subsistence, with famine following famine. It cannot be explained by the importation of any revolutionary agricultural methods from the west, for rice is still cultivated by hand with the same tools and fertilized in very much the same manner as for centuries. It cannot be explained by any improvement in the environment. Soil, area, topography, and climate all remain as they were. The only significant change has been the securing to the people of a greater degree of economic and social freedom. To the economic unification of the country and to the removal of all the cramping restrictions of feudalism, more than to any other influences, Japan owes the more abundant food supply of the present day. The released population has been able to establish new relationships to its physical surroundings much more productive than the old could ever have been.

The destruction of feudalism deprived the samurai of their incomes, and they were forced into other activities, thus augmenting the productive capacity of the country. Some became farmers, but more were absorbed in the new occupations introduced with the opening of the country, occupations that also provided an outlet for the surplus farm population.

The development of internal and external transportation and communications created a new demand for labor both for construction and for operation. With transport b[illegible]omc trade both foreign and domestic, and the merchants have c[illegible]me something more than engrossers of rice during famine pe[illegible]ds. They are no longer a despised group. The great trading families are among the most powerful and influential in Japan.

The creation of markets and the repeal of the old sumptuary laws have encouraged the development of manufacturing industries, but here, as in the case of agriculture, the more significant expansion has come not through the introduction of western inventions and methods, but through the stimulation of the household industries that have been in existence for centuries. Freed of restrictions they have developed rapidly and have offered an outlet for employment to a population increasing beyond the labor demands of the land.

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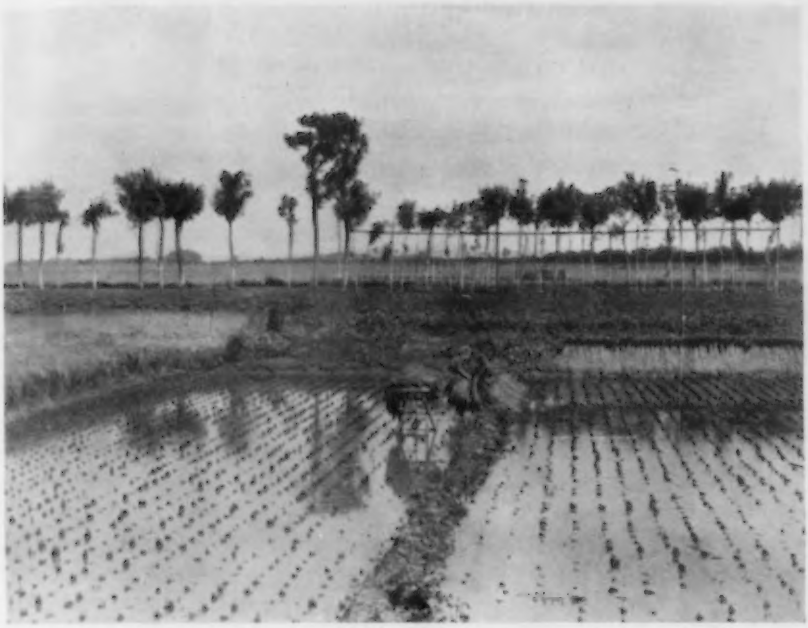


FIG. 6

FIG. 7

FIG. 6—Drying rice along the boundary ridges between the fields.
FIG. 7—Threshing wheat in a farmyard near Osaka. The grain is spread carefully on mats so that none will be lost.

some 2500 per square mile. It is this density that the leaders are viewing with alarm, the more so since Japan is still essentially agricultural. Out of the present concern has come the suggestion of a number of possible ways of absorbing the growing population.

Expansion and Intensification of Agriculture

Since Japan is and always has been an agricultural nation it was quite natural that relief should first be sought through improvement in agriculture. The physical structure of the country has greatly restricted the arable area (see Fig. 8). Surrounding the mountainous centers of the islands are narrow coastal lowlands widening out in places to fairly extensive plains or penetrating the highlands along the bottoms of narrow steep-sided valleys. In the small percentage of the surface considered arable are included not only the plains but the lower slopes of many hills and mountains that have been terraced into rice fields by the expenditure of much human toil. Some of the terraces, notably those near Nagano City, are more than a thousand years old, and for all of that time they have been in rice. In the island of Kyushu the outer crater of the volcano of Aso-san has been reclaimed, and now in the crater bottom there are some twenty villages. Rice fields cover the floor and mount in steps far up the crater rim. In the center rises a cloud of sulphurous smoke from the new crater, an ominous warning of the fate that may await those whom the pressure of numbers has forced so near. There is in Japan little more hill land that can be made ready for rice. The plains have long since been claimed by man with the exception of the belts of barren gravel land so common along the lower courses of Japanese streams. A part of those lands may perhaps be reclaimed but only by large-scale operations conducted by the government or by a corporation, and the area thus brought under cultivation will add relatively little to the area already in use.

Though it is a matter of vital importance, no careful survey and classification of the land area of Japan has been made in recent years. It is estimated, however, that there still remain in the country about five million acres that may be reclaimed, an area about one-third of the present arable area. About one-half of it is considered to be suitable for conversion into rice paddies. The total estimate seems large even though it does include the boundary ridges and pathways that are to be saved by the consolidation of small fields and the redivision of farms. If it is accepted, however, with the rather improbable assumption that the land will be as productive as the land now under cultivation, there seems to be the expectation of increasing the food supply by some 33 per cent, or sufficient for a population increase of 20 million.

That this expectation is unduly optimistic seems evident from an examination of the history of land reclamation in Japan. In the twenty years between 1905 and 1925 the arable land was increased by about 1,875,000 acres, or an average annual addition to the land under cultivation of less than 100,000 acres. At such a rate it will require 50 years to reclaim the estimated possible area, but the 20

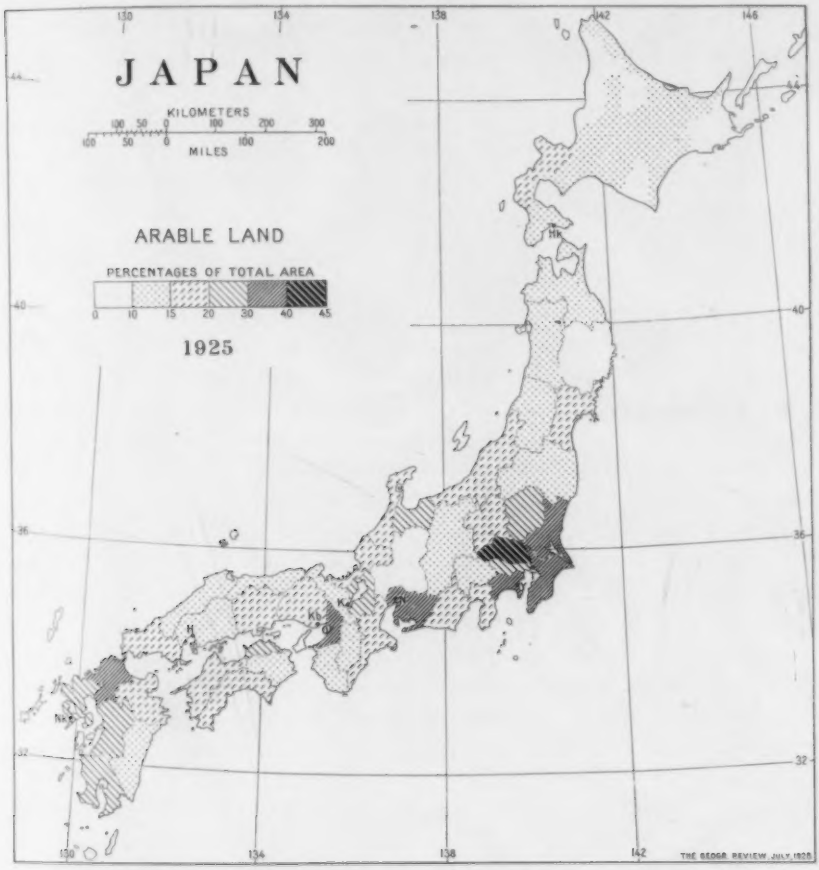


FIG. 8—Percentage of arable land in relation to total area by prefectures, 1925. Scale approximately 1:14,500,000.

million population increase will be reached in less than 25 years. It is not likely that even this slow rate of reclamation can be maintained, for the later projects will probably be more difficult. Already a decreasing rate of reclamation is evident. In the ten-year period from 1915 to 1925 the average acreage reclaimed annually was only 50,000 acres, or one-half of the average for the last twenty years. For two of the years there was a decrease in the area of land under cultivation amounting to almost 150,000 acres, indicating that the work of reclamation

has pushed very close to the margin. It is significant that 46 per cent of all the land reclaimed since 1915 has been put into mulberry, not into food crops. Mulberry is grown only on land that is unfit for rice because of soil, topography, or scarcity of water. It is also significant that, since 1915, 49 per cent of the land newly brought into cultivation and 56 per cent of the increase in rice land has been in Hokkaido, the scantily populated north island.

That the government does not have too high hopes of reclamation as a solution of population growth is shown by the announced plan of the recently appointed commission on food and population. The commission has proposed the reclamation of only 75,000 acres per year over a period of 25 to 28 years. It is a feeble effort, for that area will add each year only 30,000 farms of the present average size and will support a farm population of not more than 150,000, an insignificant figure in view of the present annual increase of approximately one million.

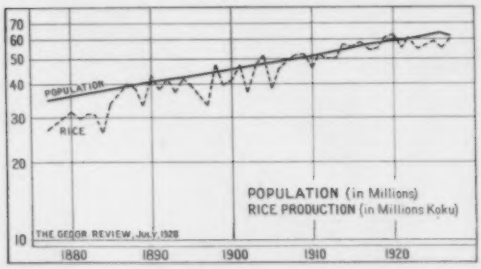


FIG. 9—The population of Japan and the rice production have increased at almost the same rate in the last fifty years. (Graph on semi-logarithmic scale.)

Some increase in agricultural output is to be expected from improvements in farming methods. Since 1880 there has been an increase of 93.6 per cent in the total production of rice, three-fourths of which has been due to a higher yield per acre and only one-quarter to an increase in area under cultivation. This is a remarkable record, but it does not contain much promise for the future, for it is an indication not only that land is scarce but that the Japanese are already getting the most out of what they have. There would be more hope for further increase if the Japanese had not proved themselves to be such skillful farmers. They have much to teach the western world in the maintenance of soil fertility and in forcing the land to bring forth large yields. The output of rice for the five years 1921–1925 averaged 2350 pounds per acre. In the United States it was only 1076 pounds; and in Java, another land of intensive cultivation, it was 927 pounds. From planting to harvesting, Japanese agriculture is carried on almost exclusively by hand without the aid of machinery or even of animals. It is difficult to see how it can be made much more intensive, for after all there is a limit to what the land can be made to produce. Already the yield per acre is advancing at a much slower rate than in the earlier years of the modern period (see Fig. 10). Certainly it is not keeping pace with the increase in population. Japan cannot count on intensification as a solution of the problem.

Possibilities of a Change in Diet

There is perhaps a possibility of providing for a somewhat larger population by a change in diet. It is even probable that such a change would not only increase the available food supply but would prove beneficial to the health of the people. Dr. Egerton Charles Grey has recently completed a study of the food problem in Japan for the League of Nations. His preliminary report contains some interesting conclusions.[13] He has found that as far as quantity is concerned there is no shortage of food in Japan and that there has not been at any time since the beginning of the Meiji era. It is his opinion, however, that the Japanese are poorly nourished because of the preponderance of rice in their diet. Certainly any foreigner who spends a few weeks in Japanese inns, delightful as they are, finds the diet very trying. A greater dependence on vegetables and fruit would undoubtedly cut down the demand for rice. The land might be made to yield more starch in the form of the white potato or sweet potato. In recent years Germany, with much less intensive methods than are practiced in Japan, has been able to secure slightly more starch per acre from potatoes than Japan has secured from rice. The sweet potato is more at home in the climate of Japan than the white potato, and it will grow on land too steep and too dry for rice. Changes in diet, however, are not easy to bring about even among the most progressive peoples. It is certain that the Japanese would regard a change from rice as a lowering of their standard of living. It could come only after a long educational campaign or as the result of a food shortage. It is one of the least promising of the proposed solutions for the Japanese population problem.

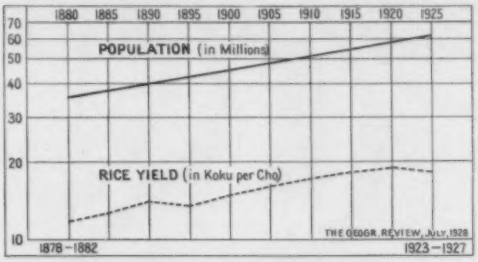


FIG. 10—Comparison of rice yield per cho and population growth. Recently the increase in yield has not kept pace with the increase in population. The yield is by five-year averages; the population is charted for every fifth year. (Graph on semi-logarithmic scale.)

Population Relief through Emigration

Other nations have sought relief for a too numerous population in migrations into less densely populated lands. When Japan finally began to look about for new lands to absorb her surplus population, it was a century too late. She was in much the same position as Germany after the formation of the Empire in 1871. Very few parts of the world remained that were not already claimed by one of the great colonizing

[13] *Trans-Pacific*, July 30, August 6, and August 13, 1927.

FIG. 11

FIG. 12

FIG. 13

FIG. 11—Steep slopes are carefully terraced for tiny fields of rice.

FIG. 12—The crater floor of Aso-san is in rice; tea is grown on some of lower slopes; forests above.

FIG. 13—Rice drying on rope frames stretched between roadside trees.

powers of Europe, and the lands that had not been appropriated were of little value for settlement. Japan, however, lost little time in striving to overcome the handicap of a late start. In 1875 she secured from Russia the Kurile Islands in exchange for her claim to the island of Sakhalin. In 1876 she seized the Ryukyu Islands. She was victorious in her first great war, the war with China in 1895, and Formosa and the Pescadores were added to her territory. By the war with Russia in 1904–1905, Japan gained a foothold on the mainland of Asia and regained the spoils the European powers had forced her to surrender at the conclusion of the war with China. She secured a dominant position in South Manchuria and a protectorate over Korea which gave way to annexation in 1910. She also recovered the southern half of Sakhalin traded to Russia in 1875. By the Treaty of Versailles Japan was given a mandate over some of the German islands in the South Pacific and acquired the German claims in Shantung, claims which have largely been returned to China.

With all her strenuous efforts to acquire territory extending over more than

half a century, Japan has not been able to build up a large empire. Her external possessions constitute only about 44 per cent of her total area, and some of her claims are not any too secure—her hold on Manchuria for instance. Korea is restless, and Japan has been forced to accede to a number of the Korean demands.

Nor has the territory acquired proved to be an effective outlet for an overflowing population. The Japanese have not migrated in any large numbers to the empty parts of the main group of islands, to her outer possessions, or to the controlled zone in Manchuria.

Hokkaido

For a time Hokkaido was looked upon as the solution of the Japanese population problem. It has been called the Northland of Japan. Certainly it is the Japanese frontier area. At the beginning of the Meiji era, it was an empty wilderness inhabited only by a few tribes of the Ainu. In 1869 a Colonial Development Office was created as a part of the new government of Hokkaido. American engineers, geologists, and agriculturists were brought in to build

Fig. 14

Fig. 15

Fig. 16

Fig. 14—Barn and silo, dairy cows, and turnip field of this Hokkaido farm recall New England.

Fig. 15—Harvesting rice in Hokkaido in October. The heavy clothing is evidence of the rigorous climate.

Fig. 16—Threshing oats. Even in Hokkaido with its larger farms little machinery is used.

railways, open the coal fields, and assist in the development of the island. An agricultural college on an American model was established in Sapporo, the capital; and American fruits, vegetables, and grains were introduced. An active campaign to colonize the island was launched by the government. In 1869 the population was 58,000, or less than 2 persons per square mile. By 1901 it had increased to over one million, and by 1925 it exceeded two and a half million.[14]

FIG. 17—The stove has invaded Hokkaido with its New England climate: its use demonstrated in the street market.

Despite this seemingly rapid rate of increase, however, Hokkaido has not been an important outlet for the population of the main islands. In only two years, 1907 and 1917, has the total net increase, including births as well as migrants, exceeded 100,000; and in both 1923 and 1924 the rate of increase per 1000 was less than for all of Japan. In 1926 the Hokkaido government announced that the island could accommodate 1,770,000 more people,[15] or about the increase of Japan for two years. It was also announced that the government planned to send 90,000 farmers a year from Japan to Hokkaido for the next twenty years. There is little probability of the successful execution of such plans unless there has been discovered some new and extremely potent method of encouragement. The Japanese official figures on the population of Hokkaido are confused, but apparently the greatest annual movement into the island was about 38,000 during 1917, 1918, and 1919. In 1924 less than 10,000 migrated into Hokkaido from other parts of Japan, and more than 11,000 returned to the southern islands or to other parts of the Empire. The story is much the same for all of the years since 1920.

Hokkaido will play no important part in absorbing the growing population of Japan. The area of arable land is not large, and the climate is rigorous with winters much like the winters of New England.

[14] Hokkaido Statistical Bureau, Statistical Report, Part I, 1924 (in Japanese). Also *Résumé Statistique*, 1926.

[15] *Tokyo Nichi Nichi*, June 26, 1926.

The immigrant must make revolutionary changes in his way of living, and the Japanese have never proved themselves to be a people capable of easy adaptation to unaccustomed and unfriendly conditions. The lightly constructed houses of southern Japan are not sufficient, and Hokkaido architecture is more Occidental than Oriental.

Karafuto

Karafuto, the name given to the Japanese part of the island of Sakhalin, is even less likely to attract Japanese emigrants, for it is several degrees farther north than Hokkaido and its winters are much more severe owing to its position near the Asiatic continent. There is some cultivation of wheat, but the economic life is based almost entirely upon the fisheries, forests, and mines. The total Japanese population is 138,000; and in 1923, according to the *Japan Year Book*, 9340 peasant settlers entered Karafuto from Japan, 5700 of them from Hokkaido. The Director of Agricultural Affairs of the Sakhalin Government recently informed the Commission for the Investigation of the Problems of Population and the Food Supply of the Imperial Government that the island had need of 100,000 workers for the exploitation of coal mines and for the lumber industry, not a very attractive prospect for the warmth-loving Japanese farmer.

Korea

The climate of Korea, the southern part at least, is somewhat more to the liking of the Japanese, but Korea is already rather densely populated, having 229 per square mile in 1925, and the topography is rugged. The standard of living of the Koreans is lower than the standard of the Japanese. The wage scale is about one-half of the Japanese rate. Korean boys are brought into Japan to serve as helpers in industries where wages must be very low.

The Governor-General of Korea has announced to the food and population commission that an area of 500,000 acres of rice land has recently been developed and that 350,000 Japanese are required to work it, but the Japanese farmer finds it difficult to compete with the Korean farmer. If so much land is available, it is difficult to understand the Korean immigration into Manchuria and the report that Viscount Goto on his recent trip to Russia discussed with the Soviet Government the possibility of emigration from Korea to the rice fields of the Siberian Maritime Provinces. It would seem that Korea also is seeking relief for population pressure.

There has been a considerable movement from Japan into Korea, but almost half of the 400,000 Japanese in the country in 1924 lived in the eight largest cities. They were not farmers; they were mer-

chants, bankers, and officials. Korea may possibly become a source of food and raw materials for Japan, but it will not provide land for the surplus Japanese farmers.

Formosa

Taiwan, or Formosa, has a moist, hot climate capable of a large production of tea, rice, sugar, camphor, and timber. The Japanese have achieved a considerable degree of success in their subjugation of the natives and the administration of the island, but the total population of 4,000,000 in 1924 included only 183,000 Japanese. The Director of Colonial Affairs recently stated that Formosa could absorb 300,000 Japanese within the next 10 years. Since 1915 the increase in the Japanese population of Formosa has averaged less than 5000 per year.

The outlying parts of the empire offer little relief for Japan's population problem. The pioneer areas are all lands of limited possibilities that can only be brought into use slowly. Even accepting the claims that the heads of the various colonial governments are now making to the Imperial Government, it would seem that the colonies, including Hokkaido, can absorb in the next twenty-five years a total of less than 2,500,000 migrants. In view of the evidence at hand it is likely that these claims are pious hopes from enthusiastic administrators rather than considered estimates of potentialities.

Manchuria

At the conclusion of the war with Russia, Japan acquired the Russian lease on the Kwantung Province, an area of 1300 square miles in the southern part of the Liaotung Peninsula, Manchuria, and also the South Manchuria Railway with control of a narrow strip along the right of way.

Manchuria was looked upon as the land of promise, and the Japanese government early announced its intention of sending one million colonists within a period of ten years into the territory under Japanese control. By the end of 1923, almost 20 years after Japan had taken over the territory, there were only about 87,000 Japanese in Kwantung out of a total population of 707,000, and practically all were in the two cities of Dairen and Port Arthur. In the railway zone there were 82,000 out of a total population of 238,000. There were not more than 35,000 Japanese in the other parts of Manchuria not under Japanese control, making a total Japanese population for all of Manchuria of only a little over 200,000. It is also significant that only about one-half of the Japanese in Manchuria are agriculturists. The remainder are merchants or are attached to the South Manchuria Railway or to the enterprises established by it. In 1924 in Kwantung

Leased Territory there were 167,087 Chinese farmers but only 148 Japanese farmers according to the Director of the South Manchuria Railway.[16]

Manchuria is a rich land. The area is extensive, the soil fertile, and the proportion of plains much larger than in Japan or even than in China proper. In 1923 the population density was only 61 per square mile. Since the establishment of the Chinese Republic in 1910 there has been an annual movement of laborers for the harvests, but most of the workers returned home at the end of the season. More recently a flow of permanent settlers with their families has set in, partly because of the disturbing and destructive effects of the many civil wars in China and partly because of famines. The present famine in Shantung Province is responsible for a greatly accelerated movement. It has been stated on good authority that over a million[17] Chinese are entering Manchuria each year and that more than half of them are remaining as permanent settlers.

The Chinese peasant works for a year or two as a laborer. Then he takes a piece of land and for a time leads a very meager existence. He perhaps digs a cave to serve as a shelter for himself and family until there are time and money to provide a better home. His food supply will be scanty and precarious, but he has always been very close to the margin of subsistence. With such a standard of living the Japanese farmer finds it impossible to compete. The climate of Manchuria is more rigorous than that of Japan, but it is warm enough to permit the cultivation of rice and in itself probably would not prevent Japanese migrations. The Japanese have never been able to establish the practical right to lease land in Manchuria for settlement or for any other purpose. Though one of the twenty-one demands of 1915 gave to Japan that right, the Chinese have managed to put effective obstacles in the way of its enjoyment. Even for extensions of the South Manchuria Railway it has been necessary to secure leases of land through a Chinese who thus becomes assured of a good income for life. The Chinese farmer who takes land in Manchuria benefits from any increase in value. The Japanese settler cannot enjoy such increment. This impossibility of competition with the Chinese peasants seems to be the fundamental cause of the failure of Japanese settlement in Manchuria, though it is true that the Japanese made no more headway during the period before the present Chinese movement began.

Manchuria is one of the few unexploited regions of the middle latitudes, and its position adjacent to areas of dense population makes it one of the world's danger spots. The stage seems to be set for a

[16] Kimmochi Okura: Japan's Future in Manchuria, *Japan Advertiser*, August 12, 1926, p. 5.

[17] *Trans-Pacific*, September 24, 1927. Also Chinese Government Bureau of Economic Information, Peking; C. W. Young: Chinese Labor Migration to Manchuria, *Chinese Econ. Journ.*, Vol. 1, July, 1927, noted in *Geogr. Rev.*, Vol. 17, 1927, pp. 674–676.

colossal conflict with the outcome very much in doubt. The contest for Manchuria, for years a two-sided struggle between Russia and Japan, has now become a three-cornered struggle with the active entrance of China. Russia and Japan have the organization and the military strength; China is badly torn by civil wars, but she has the advantage of proximity and in her migrants a most effective weapon to protect the sovereignty that still remains to her and perhaps even to regain the rights that she has been forced to surrender.

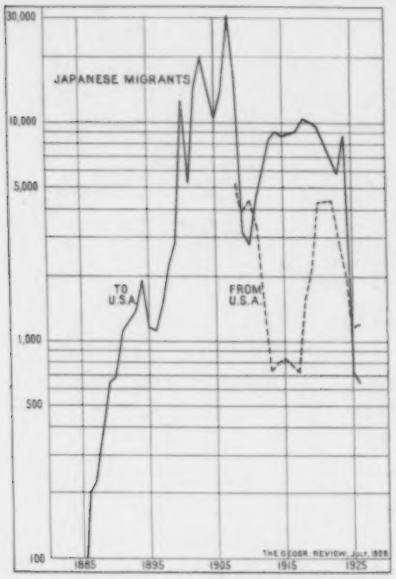


FIG. 18—Annual migration movement of Japanese to and from the United States, 1885–1926. (From the United States Department of Labor, Annual Report of Commissioner General of Immigration, 1926.)

If a conjecture may be permitted, China will not be the loser in this struggle. Though the Japanese are inclined to underrate the capacities of the Chinese, it is the Chinese who are making the greater progress in Manchuria. That opinion is beginning to gain ground in Japan. As a Japanese economist recently stated: "If there were ever a hope for Japanese dominance [in Manchuria], it was the first ten years during which we wished to colonize to the extent of 1,000,000 immigrants. It is too late now."[18]

EMIGRATION TO FOREIGN COUNTRIES

Japan has in the past attempted emigration into foreign countries, but the movement has been of far greater significance for the political issues it has raised than for the actual numbers involved. Foreign migrations did not become important until the last decade of the nineteenth century. During the previous ten years the largest annual migration to the United States was 640 in 1889, and in 1880 it was only 4. Even during the height of the emigration to the United States, just prior to the formulation of the Gentlemen's Agreement of 1907, the average number of Japanese to come to this country annually was less than 18,000, and they were returning home at the rate of about 4000 per year.[19]

Emigration in recent years has been particularly unimportant. Prime Minister Tanaka in July, 1927, stated that not more than 15,000

[18] S. Washio: *Trans-Pacific*, Oct. 29, 1927.

[19] U. S. Department of Labor, Annual Report of the Commissioner General of Immigration, 1926, pp. 166, 170.

Japanese were migrating to foreign countries annually. For the years from 1920 to 1924 this number was exceeded by the repatriations.[20]

According to the Bureau of Statistics of the Imperial Cabinet there were 625,000 Japanese residing abroad on October 1, 1925. The *Osaka Mainichi* (June 30, 1926), however, has stated that that number included about 22,000 Koreans and Taiwanese and about 57,000 students, officials, tourists, army and navy officers, and others who should not be considered as migrants. The total number of emigrants was therefore approximately 546,000; and of that number probably 45,000 were farmers, merchants, industrialists, and workers in Kwan-

TABLE I—ESTIMATED NUMBER OF JAPANESE EMIGRANTS TO BRAZIL*

1908	799	1914	4,526	1920	983
1909	4	1915	39	1921	923
1910	911	1916	35	1922	965
1911	0	1917	3,883	1923	891
1912	2,859	1918	5,903	1924–1925	3,689
1913	6,957	1919	2,678	1925–1926	4,908
				1926–1927	8,599

* *Japan Advertiser*, August 19, 1926; *New York Times*, November 13, 1927.

tung Province, in reality Japanese territory. Of the remaining 500,000, 50 per cent were in the Continental United States, Hawaii, and the Philippine Islands, lands now closed to Japanese.

The lands bordering upon the Pacific Ocean that are seemingly the most suitable for Japanese settlement are for the most part under the control of English-speaking people, and they now have rigid restrictions, if not exclusion acts, with respect to the immigration of all Orientals. On the other hand, the Japanese are a home-loving people. They have never shown themselves to be pioneering folk eager to make new settlements or to combat strange surroundings.

Practically all of the few suitable localities remaining open to Japanese are in South America. Japanese emigration is being directed toward Brazil and to a less extent toward Peru and the Argentine. The movement to Latin America was of no importance as long as the United States permitted Japanese to enter freely, and even since the Gentlemen's Agreement it has been sporadic. There are now in Brazil approximately 55,000 Japanese. In the official year 1926–1927, of the 16,184 emigrants leaving Japan 8599 went to Brazil.[21] Most of the Japanese are settling in São Paulo, but some are moving to southern Brazil. The Brazilian and Japanese governments are coöperating in efforts to stimulate this emigration further.

[20] Japan, *Financial and Economic Monthly*, August, 1927. Migration Movements 1902–1924. *Internatl. Labor Office Studies and Repts.*, Ser. O (Migration), No. 2, Geneva, 1926.

[21] *New York Times*, November 13, 1927.

The attention and encouragement given to emigration by the present Japanese Government are strong evidence of the desperate circumstances of the country. Most elaborate plans have been formulated. Emigrant associations are being organized under the Japanese Foreign Office and provisions are being made for the physical comfort of the emigrants in their new homes. The Foreign Office is providing a subsidy of 200 yen for each individual, and the Home Office is lending funds for passage money and for the purchase of land; but the funds available are limited, and the present plans provide for only 200 families in three years. Financial assistance is being granted only to those who intend to leave Japan permanently and to become citizens of the countries in which they establish themselves. To stimulate interest in foreign lands a colonial museum is to be established in Tokyo, and colonial or emigrant schools have already been started to train prospective emigrants in the language, customs, resources, and economic possibilities of their future countries.

But despite all of the publicity given to them, these plans should be heavily discounted. They have a strong political flavor and have been put forward by the party in power to win popular support. Practically every one of the plans has served the same purpose at one time or another in the last quarter of a century; but they have all remained paper plans, and the results accomplished are of no importance. Japan really places little hope in emigration to solve her population problem.

Birth Control

The possibility of positive checks on population growth has received serious consideration only within the past few months. Three years ago the discussion of birth control was "dangerous thought" and was hunted out and suppressed by the police as vigorously as communism is today. In the fall of 1926 at a luncheon given by a group of professors of Japan's most liberal university, birth control was mentioned in the course of a discussion of Japan's future and of her population problem. It was dismissed as a method of population control because it was so entirely contrary to Japanese ideals. It is significant of the changing trend of Japanese thinking that the professor who voiced the most decided objections to birth control has since declared in a printed statement that it is the only possible solution of Japan's population problem.

It is a change in philosophy that is today very widespread in Japan. The birth control movement has made little headway with the masses, but it is being discussed widely in newspapers and magazines. It is openly advocated by many economists. Recently it was debated before a large audience in Tokyo by a professor of the Tokyo Imperial University and a professor of Waseda University. It is even being considered by the government, and in view of the circumstances that

encompass the country it seems probable that within a few years there will be a complete reversal of government policy to an active encouragement of positive checks on the population growth. The strong paternalistic government of Japan is well suited to make the experiment with birth control not only for the limitation of numbers but for the improvement of the stock.

A Brief Consideration of Industrialization

One other means of providing for an increasing population remains to be considered. Other countries, notably England and Germany, have been able to provide for greater numbers by an intensification of the use of their land area through the developing of manufacturing industries. In Japan during the past half century, the development of manufacturing industry has been actively encouraged by the government, in the earlier years in an effort to make the nation strong economically and politically and in more recent years as a means of providing employment and food for the increasing population. Industrialization is today, more than ever before, a leading issue in domestic politics. Numerous official commissions have been appointed recently to investigate the condition of industry, to survey the resources of the country, and to devise methods of encouraging the developing of manufacturing.

Despite the efforts of half a century, however, Japan is not an industrial nation. In 1924 there were in Japanese factories fewer than two million workers, representing probably less than ten per cent of the population gainfully employed. During the war Japan participated in the world-wide expansion of manufacturing and experienced the greatest industrial advance of her history. In the five-year period from 1914 to 1919 there was an increase of 838,000 in the number of factory workers, or an average increase of 167,600 annually.

The expansion proved to be solely a war product, for Japan experienced in a severe form the post-war depression. In the five year period from 1919 to 1924 the number of factory workers declined by about 48,000.[22] It is undoubtedly a temporary setback, and Japanese manufacturing will advance again; but even if the spectacular expansion of the war period could be maintained permanently, a very unlikely development, the increasing demand for factory workers would not be sufficient to absorb the surplus population.

The subject of industrialization is a large one and demands a more detailed consideration. A later discussion will present an account of the progress of manufacturing in Japan, of specific industries, of their economic and geographic background, and an analysis of their probable future development.

[22] Japan, Dept. of Commerce and Industry, Statistical Rept. of Factories, 1924, p. 1 (in Japanese).

THE POPULATING OF WISCONSIN

Guy-Harold Smith
The Ohio State University

[With separate map, Pl. III, facing p. 420]

FOR a hundred years agricultural pioneers have been laboring to convert the wilderness of Wisconsin into the countryside of prosperous settlement. Figure 1 shows an individual farm on the agricultural frontier of today in course of reclamation from land abandoned by the lumbermen. The century of pioneering has not been

FIG. 1—A farm in the making in northern Wisconsin. (Courtesy of the Wisconsin Geological Survey.)

sufficient to erase completely the wilderness; and as will be shown later a part of that frontier still remains in the northern part of the state.

The first farmers who ventured into southern Wisconsin toiled to win wheat land from the virgin prairies and woodlands. Gradually the culture of wheat moved on westward to the treeless prairies beyond the forest belt. But in Wisconsin, the agricultural frontier moved progressively northward; and the individual farmers, with characteristic ambition and fortitude, labored to win their farms from the forest. Times had changed, and a diversity of agriculture replaced the specialization in wheat; it is well that the change had come, for to the north the open prairies were not to be found. Still farther north the modern pioneer has a slightly modified objective. Dairying has become a specialized counterpart of his diversified agriculture. Some of the cut-over land can be used for pasture, and the farm animals assist the pioneer in converting the new land into a prosperous farm.

The dot maps of Plate III present in a graphical manner the northward movement of the frontier and at the same time indicate the intensification to the rear commonly called the urbanization movement. Growth of cities and villages has kept pace with steadily moving frontier, and in recent years the attractiveness of urban life

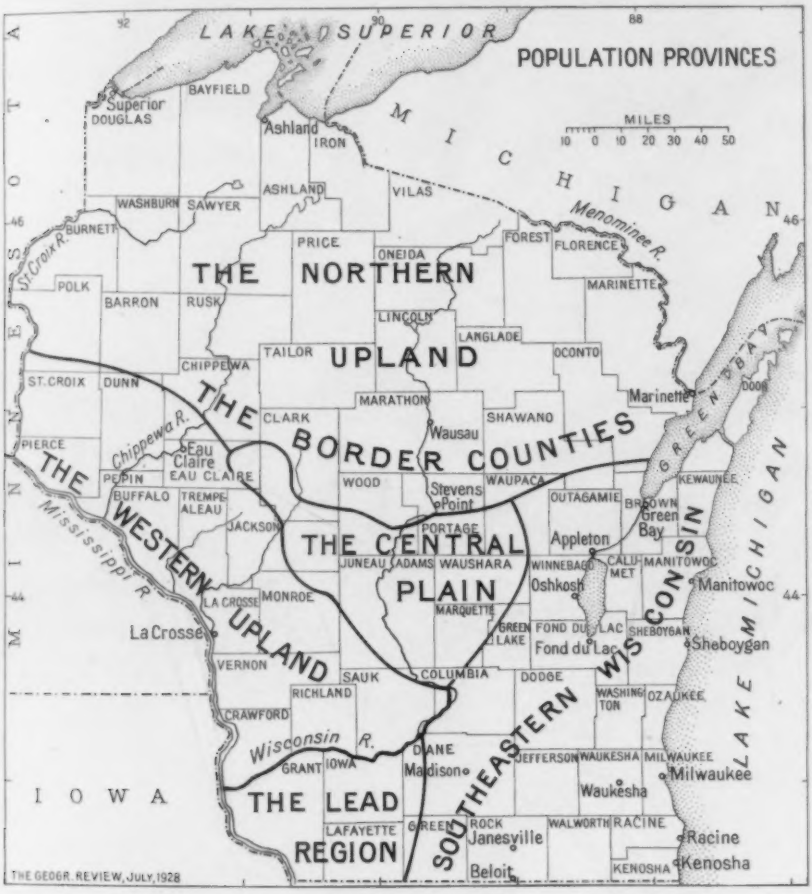


FIG. 2—The population provinces of Wisconsin. Scale approximately 1:4,400,000.

has drawn some of the rural inhabitants to the cities. Simultaneously, there have been these two tendencies: one toward a dissemination of the rural inhabitants, and the other a centralization of the urban peoples. "It is for *demography* to undertake the study both of that concentration and of that dispersion."[1]

The regions selected for this study are largely physiographic, but the order of their presentation is more or less historical in order to show how Wisconsin came by its present population distribution.

[1] Lucien Febvre: A Geographical Introduction to History, London and New York, 1925, p. 34.

The Lead Region

Unified by the presence of a mineral resource and distinguished from the contiguous territory, the lead region of the upper Mississippi Valley has had a special history. Wisconsin includes within its borders the northern portion of that mineral region and has shared in its history.

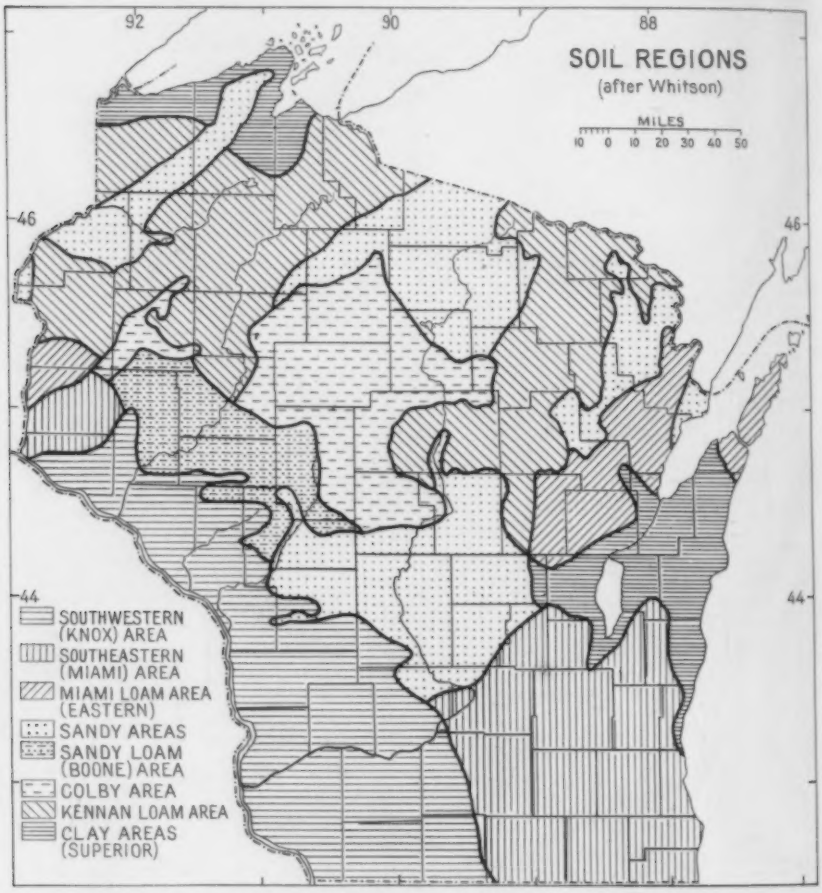


FIG. 3—The soil regions of Wisconsin. (After A. R. Whitson: Soils of Wisconsin, *Wisconsin Geol. and Nat. Hist. Survey Bull. No. 68*, 1927.) Scale approximately 1: 4,400,000.

The year 1820 is usually chosen as marking the close of the great migration. "With the admission of Missouri [1821] the great migration came to an end so far as new States were concerned, and the heavy shift of population subsided for another ten years."[2] Just as this historic movement began to abate the settlement of southwestern Wisconsin was begun; thus the first movement into the area was slow.

[2] Frederic L. Paxson: History of the American Frontier, 1763–1893, Boston and New York, 1924, p. 219.

A few miners had reached Wisconsin by 1820, but it was not until 1825 that the frenzied movement began. As the frontier of settlement approached the lead region the pioneers, attracted by the prospect of wealth, threw out a salient in advance of the agricultural frontier. The lead had been known since 1690 when the French traders bargained with the Indians for lead as well as for furs.[3] It was the approach of the frontier that increased the importance of this mineral resource, making it for a time the dominant attraction in the region.

FIG. 4—The physiographic provinces of Wisconsin. (After Martin, *op. cit.*, footnote 10.)

One significant fact concerning the early settlement of the southwestern part of the state was the direction of the movement. "The laws which, as a rule, generally confine the migration of the human race to isothermal zones and similarity of climate, were to be set at defiance, and the emigrant from the mild climate of Tennessee, Kentucky, Missouri, and southern Illinois was to exchange the balmy and genial atmosphere to which he had been accustomed, for one in which during nearly half the year all nature is bound with icy chains and covered with a robe of snow."[4] In this we find the explanation of the fact that so many people of southern origin found their way into southwestern Wisconsin: they had been attracted by the lead and guided by the Mississippi River and its tributary, the Galena, into the mineral lands.

It is difficult to ascertain the number of people in the lead region because of the scattered nature of their activity and the continual increase from immigration. For the years 1825 and 1826, the Superintendent of the Lead Mines reported that: "On the 1st day of July, 1825, there were at those mines about one hundred men; on the 31st of December, 1825, one hundred and fifty-one men; on the 31st of March, 1826, one hundred and ninety-four; on the 30th of June, 1826, four hundred and six; and on the 31st of August, 1826 (the date of the last report), there were four hundred and fifty-three men. You will

[3] Louise Phelps Kellogg: The French Régime in Wisconsin and the Northwest, Madison, 1925, p. 359.

[4] Moses M. Strong: History of the Territory of Wisconsin from 1836 to 1848, Madison, 1885, p. 118.

observe the increase has been gradual, and the numbers are still augmenting."[5] This was just the beginning of settlement, for in 1828 the northward drift into Wisconsin was heavier than in any previous year.[6]

About 1830 there began a stream of miners from Cornwall that has left in this region thousands who now claim one or more ancestors of Cornish origin. This influx is closely related to the trend of the lead-mining industry. About 1850, Cornish miners were drawn away from the lead mines to the gold fields of California. "It is estimated that in 1850 there were about 6000 native Cornish in Wisconsin, making up about one-sixth of the total population of Grant, Iowa, and Lafayette counties."[7]

FIG. 5—The prairies—in black—of western Wisconsin. (After Martin, *op. cit.*, footnote 10.)

The lead mining brought with it a certain amount of agriculture. There was a local market for farm produce; and after the Black Hawk War (1831–1832), which made the region safe for settlers, there began a steady stream of farmers into the area. In fact many found the fertile prairie soils more valuable than the uncertain business of mining. The lead ore was found widely disseminated in the zone above the water table, and this invited individual operations and produced a population dispersion rather than the usual concentration around a mine shaft. In effect they were miner-farmers and depended upon season or price of lead to determine to which industry they should devote their attention. Many came to the lead region of the upper Mississippi Valley to mine lead but remained to farm when the

[5] *19th Congr., 2d Sess., House of Repr. Exec. Doc. No. 7*, 1826, p. 8.

[6] William O. Blanchard: The Geography of Southwestern Wisconsin, *Wisconsin Geol. and Nat. Hist. Survey Bull. No. 65*, Madison, 1924, p. 57.

[7] *Ibid.*, p. 31.

agricultural frontier had overtaken them. The fertile upland prairies were easily made productive by merely turning the sod and planting wheat and corn, the two most important cereal crops of the frontier. From one of the earliest reports concerning the landscape of this region it is determined that about 37 per cent of the area was originally prairie and 63 per cent woodland.[8] The ease with which the land could be farmed brought the prairies into competition with the lead as a dominant element of the environment (Fig. 5).

The first reliable quantitative data on the population of Wisconsin, other than the estimates and partial enumerations at Green Bay and Prairie du Chien, are those of the United States Census for 1830. Iowa County, which included all of the lead-producing region in Wisconsin, had 1589, Brown 964, and Crawford 692, making a total of 3245 for the region.

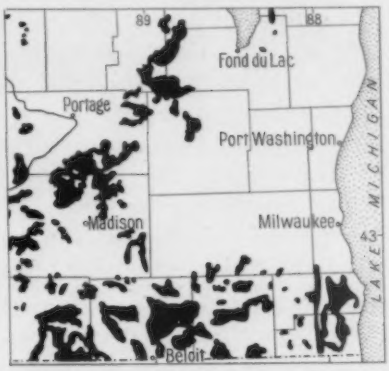


FIG. 6—The prairies—in black—of southeastern Wisconsin. (After Martin.)

The agricultural pioneers, reaching this region about 1832, created a demand for a land survey, which was begun in 1833 by the erection of the Fourth Principal Meridian through the heart of the lead region. From this line, and with the northern boundary of Illinois as a base, the surveying progressed westward toward the Mississippi River and eastward toward Lake Michigan where the pioneers were penetrating into eastern Wisconsin.

The three counties of Grant, Iowa, and Lafayette usually referred to as the lead region reached their maximum population about 1870. Since that time there has been an increase in only the larger cities and villages. The rural districts have steadily declined in population. The total number in 1870 was over 85,000—the maximum recorded in any census enumeration. In 1920 the total was 80,550. From 1890 to 1920 the number living in incorporated cities and villages increased from 18,534 to 30,705; and in the rural districts there was a reciprocal decrease from 60,499 to 49,845 in the thirty-year interval, or a removal from the farms of 350 annually. The lead region is characteristic of the older, essentially rural communities.

Agriculture gradually replaced mining as the dominant economic adjustment, although lead is still mined. After the Civil War zinc became of some importance; under the modern methods of mining both lead and zinc are recovered, and the mining population is def-

[8] David D. Owen: Report of a Geological Exploration of Part of Iowa, Wisconsin, and Illinois . . . in . . . 1839, Washington, 1844, p. 145.

initely localized in certain communities.[9] The region has taken on the aspect of the truly rural communities in the driftless portion of the Western Upland. Mining is important locally and enters into the regional economy; but most of this section is agricultural and is destined to remain rural, with a few villages and small cities to serve their respective communities.

Southeastern Wisconsin

Southeastern Wisconsin as a regional division has come to mean that portion of the state having the highest economic development and containing within its indefinite borders the major portion of the population. The region is not everywhere naturally delineated, nor has it the same combination of physical conditions over the whole area; but the distribution and the concentration of the inhabitants gives it sufficient unity to warrant regional analysis.

The northwestern boundary of this section of Wisconsin follows rather closely the frontier of 1850 and coincides roughly with the inner margin of a limestone upland that marks the boundary between the Central Lowland and the Eastern Ridges and Lowlands.[10] To the west the character of this region gradually changes until it merges into a landscape typical of the Driftless Area, within which the lead region is located. The Wisconsin glacier spread over most of the region, but toward the south there is a section of older drift with a more mature drainage development, and farther toward the southwest is an unglaciated section. The glacial landscape was generally forested, but in the southern tier of counties open prairies intermingled with woodland; and along the northwestern border of this province there were extensive openings. Door Peninsula and a strip along Lake Michigan as far south as Port Washington in Ozaukee County was pine-covered, but between the prairies and the pine forest was a great hardwood forest with maple the predominant wood. This was the landscape presented to the pioneers.

Within the region known as southeastern Wisconsin there were two early settlements. The one was Green Bay, the oldest city of Wisconsin, strategically situated near the mouth of the Fox River. In 1634 Nicolet, the first white man to visit Wisconsin, ascended the Fox River, which later became the natural route to this part of the Northwest. He had left the French settlements of the lower St. Lawrence, ascended Ottawa River, and skirted the shores of Lake Nipissing, Georgian Bay, and Lake Michigan into Green Bay. The orientation of these natural highways made Wisconsin accessible to

[9] S. L. Schubring: A Statistical Study of Lead and Zinc Mining in Wisconsin, *Trans. Wisconsin Acad. of Sci., Arts, and Letters*, Vol. 22, Madison, 1926, pp. 9–98.

[10] Lawrence Martin: The Physical Geography of Wisconsin, *Wisconsin Geol. and Nat. Hist. Survey Bull. No. 36, Educ. Ser. No. 4*, 1916, p. 30.

the growing French colonies along the St. Lawrence. This became the much used highway of the fur traders and explains the predominant French influence in Wisconsin for more than a century before the territory was lost to the British. It is only logical, then, that Fort Howard at Green Bay was selected as a military post. By 1820 when the lead region of Wisconsin began to be penetrated by the miners, there was already a settled community at Green Bay. There were ". . . about sixty houses with a population of perhaps 500 souls, besides which was a garrison."[11]

The *voyageurs* who ascended the Fox River penetrated into the interior of Wisconsin by portaging across the narrow land bridge to the Wisconsin River. The modern city of Portage now marks this strategic site, once defended by a military post at Fort Winnebago. The fort was erected in 1828, at the request of the American Fur Company to prevent the Indians from exacting toll from the traders who wished to portage from the Wisconsin to the Fox River. To these two early settlements should be added Fort Crawford, the site of which is now occupied by Prairie du Chien at the junction of the Wisconsin with the Mississippi River.

It was not until after 1832, when the danger of hostile Indians had been ended by the brief struggle commonly referred to as the Black Hawk War, that the southeastern part of the state was open to settlers.[12] This frontier struggle and the hard times in eastern cities combined to stimulate a new wave in western migration, appropriately called the Jacksonian migration.[13] Wisconsin's choicest section was then ready for settlement.

According to the census of 1830, there were 964 people in Brown County, and most of these were in the vicinity of Fort Howard at Green Bay. Six years later at the time of the Territorial Census there were 2706 in the county, or about 24 per cent of the 11,683 reported for the territory. Milwaukee County had 2893 inhabitants; and so southeastern Wisconsin exceeded the southwestern region by only a few hundred souls.

The newcomers distributed themselves over southeastern Wisconsin as a thin film of population, entering first of all the better lands in the southern tiers of counties where the open prairies offered attractive conditions to the pioneer. Where the prairies were too extensive the central portions remained unoccupied for a few years. The borders of the prairies offered an ideal combination of a woodland for fuel and building material with a prairie area for plowland.[14] Most of the land

[11] Frederick J. Turner: The Character and Influence of the Fur Trade in Wisconsin, *Proc. 36th Ann. Meeting State Hist. Soc. of Wisconsin*, 1889, pp. 52–98; reference on p. 92.

[12] Joseph Schafer: Four Wisconsin Counties, Prairie and Forest (Wisconsin Domesday Book, General Studies, Vol. 2), Madison, 1927, p. 52.

[13] Paxson, *op. cit.*, pp. 286 and 312.

[14] Joseph Schafer: A History of Agriculture in Wisconsin (Wisconsin Domesday Book, General Studies, Vol. 1), Madison, 1922, p. 36.

FIG. 7

FIG. 8

FIG. 9

FIG. 7—A typical prairie landscape in southern Wisconsin showing a farmstead protected by the characteristic exotic trees. (Courtesy of the Wisconsin Soil Survey.)

FIG. 8—A view showing the use made of gently rolling glacial landscape in eastern Wisconsin, where the favorable land conditions are the bases of the high agricultural development and the dense rural population. (Courtesy of the Wisconsin Soil Survey.)

FIG. 9—A portion of the limestone upland in western Wisconsin. (Courtesy of the Wisconsin Geological Survey.)

FIG. 10

FIG. 11

FIG. 12

FIG. 10—Dutch Valley in La Crosse County represents one of the more open valleys of western Wisconsin permitting a fair agricultural use of the land. (Courtesy of the Wisconsin Geological Survey.)

FIG. 11—A characteristic scene in the rugged section of western Wisconsin. (Courtesy of the Wisconsin Geological Survey.)

FIG. 12—The eastern margin of the Western Upland is distinctly rugged, making agriculture difficult. (Courtesy of the Wisconsin Geological Survey.)

was entered in the late thirties in the southeastern corner of the state, but settlement did not occupy all of this section until two or three decades later. In 1840 the lead region had about 8000, and the much larger and newer southeastern section had approximately 18,000 people.

By 1850 the frontier had reached the Fox-Lower Wisconsin rivers, and a vanguard had pushed beyond into a newer and a different country. The rather uniform distribution of people over the settled

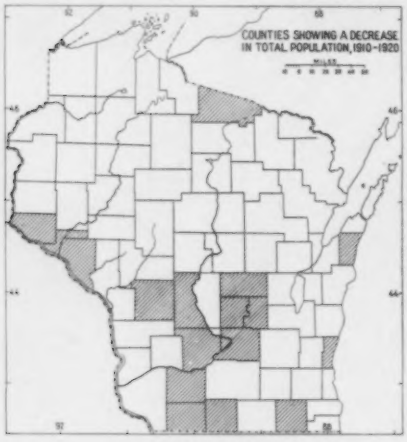


FIG. 13

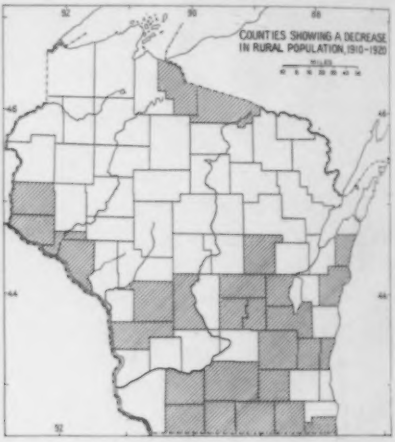


FIG. 14

FIGS. 13 and 14—Cartograms of Wisconsin counties showing decline in total and rural population between the censuses of 1910 and 1920.

portion of the state indicates equal land values. The pine-covered Door Peninsula and Manitowoc and Sheboygan counties effectively held back the frontier, while the dissected bluffs bordering the lower Wisconsin and Mississippi rivers imposed an obstacle to the conquering pioneers.

The southeastern region was destined to become the most densely populated section of the state. The large-scale dot maps show clearly the distribution and the intensification behind the frontier. The more southern counties were completely occupied by 1870. Except for a small increase in the rural population in drainage areas and in the neighborhood of cities, the agricultural population has changed but little in the last fifty years.

Because of their national predisposition to take small farms of forty to eighty acres, the most densely settled rural areas are to be found in the sections north and west of Milwaukee occupied by German immigrants. In many areas the number of rural inhabitants is nearly 50 per square mile, or almost twice as great as the density of some of the characteristic counties of the Western Upland.

The principal population changes are reflected in the growth of cities and villages concomitant with changes characteristic of the United States as a whole. By 1900—and in certain communities even earlier—there was a withdrawal of people from the farms. Of the twenty-two modern counties in the section described as southeastern Wisconsin, at least fourteen showed a decrease in rural population from 1910 to 1920, and six showed a decrease in total population in the same period (Figs. 13 and 14). It is within this section that urbanization has been important. Along the lake shore Milwaukee, the metropolis of the state, Racine, Kenosha, Sheboygan, Manitowoc, and Two Rivers have shown rapid growth since 1900. Another chain of urban centers is located in the Fox-Winnebago lowland, including Green Bay, Kaukauna, Appleton, Menasha, Neenah, Oshkosh, and Fond du Lac. Milwaukee alone had within its corporate limits over 17 per cent of the total population of the state. This process of urbanization has offset the agricultural settlement of the new lands in northern Wisconsin, and the center of population has moved eastward and southward in the two decades since 1900.

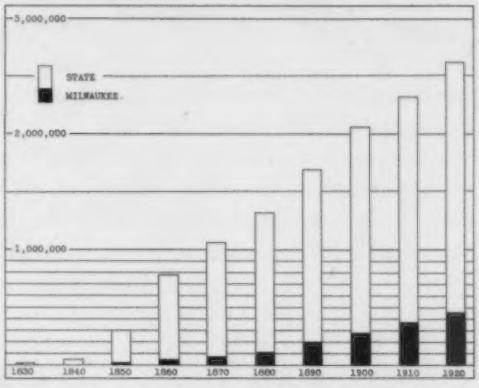


FIG. 15—Graph showing the growth of population in Wisconsin.

THE WESTERN UPLAND

The lead region already described lies within the Western Upland. The three lead counties of Grant, Iowa, and Lafayette include within their borders a portion of a limestone cuesta-upland south of the lower Wisconsin River. The topography is a gently undulating upland except along the Wisconsin and Mississippi rivers where the labyrinth of streams has dissected the area into rugged relief. The back slope preserves the upland character except locally where the streams have incised themselves to a depth of a hundred feet or more into the underlying sandstone.

To the north of the lower Wisconsin, the Western Upland assumes its characteristic ruggedness. Most of this section is within the Driftless Area, but the northern portion was covered by a pre-Wisconsin glacier. Even here the effects of the drift have been largely erased, until the line that marks the northern boundary of the Driftless Area is more or less obscure and is traced with difficulty. This is the

most rugged section of Wisconsin and may be simply described as a maturely dissected plateau having a relief of 300 to 500 feet. Locally the capping limestone has preserved wide interstream areas well suited to intensive agricultural development. This is true of both the northern and southern portions. The central division traversed by the La Crosse, the Black, and the Trempealeau rivers is in late maturity, and the ridges are too narrow for especial agricultural use. Originally the region was covered by a hardwood forest except for a strip of prairie land along the uplands in Crawford and Vernon counties.

In 1850 there were about 9000 people in that part of the Western Upland beyond the lower Wisconsin. An examination of the maps will show that there was a wave of settlement that progressed northwestward across the upland. The more southern counties were settled in the decade of the fifties, the central portion in the sixties and seventies, and the more northern region in the seventies and the eighties.

It is evident that the hilly Western Upland did not retard settlement, but its ruggedness has kept the density of the rural population below that of the southeastern part of the state. Vernon County, which lies across the upland and represents a well dissected portion, may be considered as characteristic. The county is essentially rural, having only one city with a population exceeding 2500. In 1880 Vernon had a total of 23,235 inhabitants, or 28.3 per square mile; in 1900 there were 28,351, or 34.5 per square mile; and in 1920 there were 29,252, or 35.6 per square mile or only 32.5 per square mile if simply the rural population is considered. In southeastern Wisconsin, Dodge County may be selected as representative of the densely populated region. In 1900 Dodge County had 41.5 rural inhabitants per square mile, but by 1920 this had been reduced to 37.2 persons per square mile. Sheboygan in 1920 had 49.0 rural inhabitants per square mile. It is obvious that the ruggedness of the topography and the small proportion of arable land available for farms have prevented a dense rural population. However, the development of the dairy industry, which permits a profitable use of the steep slopes for pasture, has permitted a comparatively high economic development.[15] But the ruggedness of the landscape has imposed a barrier to communication, and the consequent isolation has had its retarding effects.

Furthermore, the Western Upland lies on the wrong side of Wisconsin to benefit from the commercial activities dominant along Lake Michigan and so is handicapped under modern economic conditions. It is doubtful if the Mississippi River, developed into an important waterway, could stimulate more than a slight awakening of certain cities that are strategically situated, as for instance La Crosse and Prairie du Chien.

[15] G. T. Trewartha: The Dairy Industry of Wisconsin as a Geographic Adjustment, *Bull. Geogr. Soc. of Philadelphia*, Vol. 23, 1925, pp. 93–119.

The Central Plain

This crescent-shaped area underlain by the weak Cambrian sandstone is a conspicuous physiographic region in the central part of Wisconsin. Toward the northwest it narrows and becomes a transitional zone between the Western Upland and the Northern Highland. The northeastern portion was recently glaciated, and the thick mantle of drift has obscured the underlying sedimentary formations. Fur-

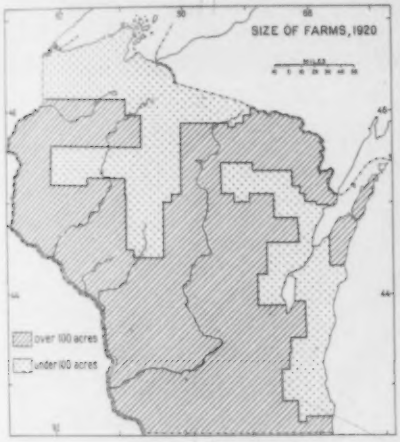


Fig. 16

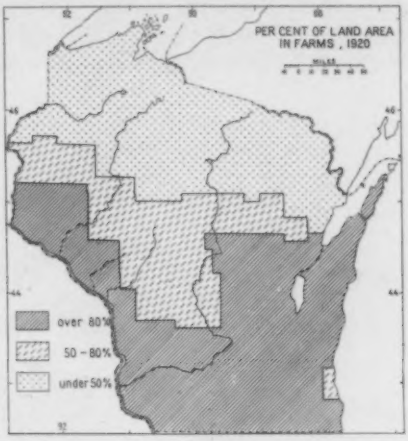


Fig. 17

Figs. 16 and 17—Cartograms showing the size of farms and the percentage of land in farms in Wisconsin (1920).

thermore, the pine forest made the area much like the glaciated portion of the Northern Highland and in a similar way has retarded the agricultural invasion of the area.

The portion of the Central Plain that may be considered typical lies within Clark, Jackson, Wood, Juneau, Adams, Portage, Waushara, and Marquette counties. Its geological boundaries are blurred, especially along the eastern border where glaciation has affected the area. The region is relatively infertile, offering only slight opportunities for agriculture. It was the first barrier to the settlement of the land to the north.

Adams County may be chosen as representative of the unglaciated portion of this sandy lowland. In 1850 there were only 187 people in the county, but ten years later there were 6492. Three successive decennial enumerations show almost a static population; but in 1900 there were 9141, and in 1920 the largest population was recorded—a total of 9284. That is 13.6 per square mile, or less than a third of the density of the rural population of Washington County in the southeastern part of the state. A large part of Juneau, eastern Jackson, and southern Clark counties is similar in physical conditions to Adams

FIG. 18

FIG. 19

FIG. 20

FIG. 18—A characteristic view of the sandy Central Plain. The small amount of cleared land is evidence of its low value. (Courtesy of the Wisconsin Geological Survey.)

FIG. 19—Waste land of the Central Plain. The wood will hardly pay for cutting, and the land is not worth clearing. (Courtesy of the Wisconsin Geological Survey.)

FIG. 20—An abandoned farm along the western margin of the Central Plain. (Courtesy of the Wisconsin Geological Survey.)

FIG. 21

FIG. 22

FIG. 23

FIG. 21—An outer moraine and an outwash plain in eastern Portage County. The favorable topography is offset somewhat by the light soils. (Courtesy of the Wisconsin Geological Survey.)

FIG. 22—Pine stumps used for a fence on one of the newer farms in central Wisconsin. (Courtesy of the Wisconsin Geological Survey.)

FIG. 23—This view illustrates the success of the pioneers in conquering the wilderness of northern Wisconsin. (Courtesy of the Wisconsin Geological Survey.)

County; and the density of population is similar and directly related to the low intrinsic value of the land (Figs. 18, 19, 20).

To the east of Adams County lies Waushara, almost wholly within the glaciated area. Both counties are underlain by the Cambrian sandstone, but across Waushara the Wisconsin glacier spread a veneer of drift in which are mixed limestone and igneous boulders. The decomposition of this heterogeneous mixture has produced a soil superior to that in Adams County (Figs. 21 and 22). The population of Waushara County from 1860 to 1910 has shown a steady increase. The 1920 census showed a decrease of 11.5 per cent; but the density was 25.8 per square mile, almost double that of Adams County.

The sandy central lowland has patches of silt soils within larger areas of sand, and a few farmers who were fortunate in the location of their farms are reasonably prosperous. There are, however, hundreds of farmers who have abandoned their farms after a few years' trial, and recently the question of unpaid taxes has become serious.

The belt of sand country that attracted the pioneer because it was level is of doubtful value. Farmers bought land here and failed, and later the process has been repeated in the same area. As previously stated, the sand plain became a barrier to the settlement of the superior farm land to the north of it.[16]

Northern Wisconsin

The westward march of the frontier across the United States "passed by" northern Wisconsin. In the seventies the population of the state increased 260,827, or 24.7 per cent; Iowa showed an increase of 430,595, or 36.1 per cent; and Minnesota added 341,067 to her population, a gain of 77.6 per cent. It is evident that the advance into Wisconsin had been slowed down. The northern part of the state lies off the principal highways followed by the home seekers. Furthermore, the prairies to the west offered greater opportunities to agriculturists than did the heavily forested land to the north.

In northern Wisconsin there has been preserved a part of the frontier, while the southern part of the state has experienced an intensification of population by the process of urbanization comparable to the general trend in the eastern United States. This combination of frontier and settled sections has produced a regional division of inhabitants on some of the economic problems of the state, as for example, the conservation movement.

Just as the fur trader pioneered into the wilderness of northern Wisconsin, the lumbermen with ax and saw overlaid a new industry on the site of the old. The settlement of the treeless prairies of the

[16] John D. Black and L. C. Gray: Land Settlement and Colonization in the Great Lakes States, *U. S. Dept. of Agric. Bull., No. 1295*, Washington, 1925, p. 12.

FIG. 24

FIG. 25

FIG. 26

FIG. 24—A landscape that can effectively hold back the encroaching agricultural frontier. (Courtesy of the Wisconsin Geological Survey.)

FIG. 25—A portion of the ancient peneplain in Marathon County. The heavy soil of this section of the unglaciated Northern Highland is the basis of a prosperous agricultural community. (Courtesy of the Wisconsin Geological Survey.)

FIG. 26—A more dissected portion of the peneplain in Marathon County. The characteristic hardwood forest is well represented. (Courtesy of the Wisconsin Geological Survey.)

upper Mississippi Valley created a demand for lumber which the forests of Wisconsin and adjacent states were made to supply. The Mississippi and Wisconsin rivers and their tributaries not only drained the water from pine-covered northern Wisconsin but drained the lumber as well into the prairie states. About 1870 the industry took on the qualities of a lumbering boom. "For forty years lumbering was the dominant interest in the northern half of the state. Into the pineries every winter went small armies of men. Down its rivers every spring the river-men drove thousands upon thousands of pine logs. Along these rivers hundreds of saw mills stood. Around the mills grew up the lumbering towns."[17] Contemporaneous with the development of the lumber industry, and necessary to its successful prosecution, the railroads threaded their way northward toward Lake Superior. By 1871 the Wisconsin Central reached Stevens Point and in 1877 was completed to Ashland. Extensions and so-called "logging roads" brought the pinery within the pale of the lumber market.

In northern Wisconsin the advance of the series of frontiers did not follow either in point of time or in type the sequence in southern Wisconsin. The frontier of the hunter and the trader had a longer lease of life and reluctantly gave way before the cutting edge of the lumberman's frontier. For almost half a century the pioneer woodsmen extended their salients up the rivers and later along the railroads until the primeval forest was separated into isolated areas of unconquered pine.

The destruction of the forest did not leave in its wake farm land of such high potential value as in the hardwood areas to the south. The idea, and perhaps the need, of conservatism came too late to save a part of the forest on land unsuited for agriculture (Fig. 24). Because of the lack of easily cultivated prairies, the low intrinsic value of the land, and the severer climatic conditions, the agricultural frontier passed very lightly across the northern part of the state leaving in its wake only a sparse population (Figs. 1 and 23).

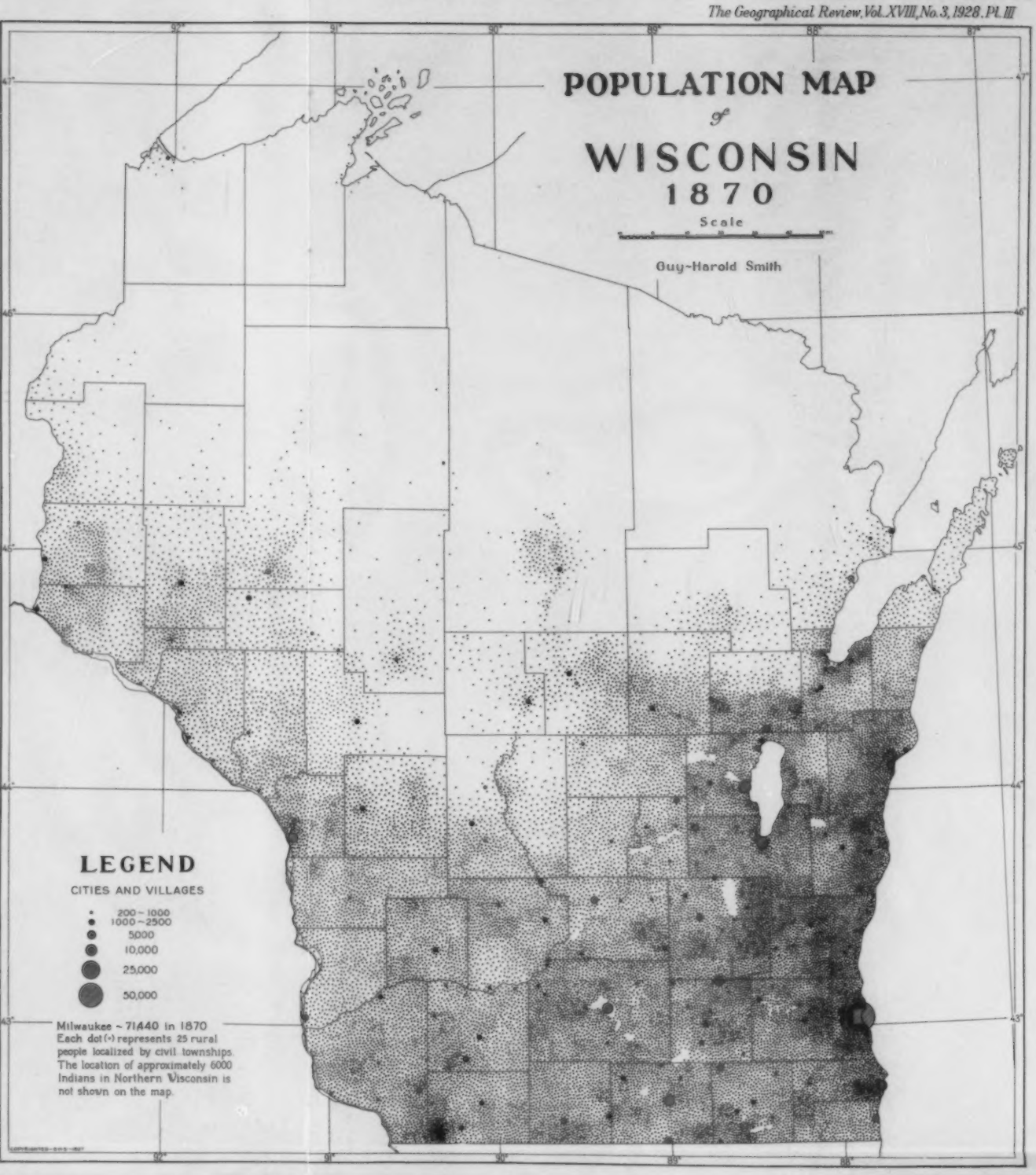
Under the stimulus of the historical westward migration land-hungry farmers, assisted by none-too-scrupulous colonizers, have settled upon marginal land and under the discouraging economic conditions that have robbed them of their anticipated rewards have lost their ambition and become marginal farmers. There are too many farmers in northern Wisconsin who have failed in their effort to accumulate more than the mere necessities of life. The State Bureau of Immigration is working toward the placement of pioneers upon farm land that will yield them a fair reward for their efforts and is preventing land companies from selling poor land to newcomers who do not fully appreciate the hardships of the pioneer.

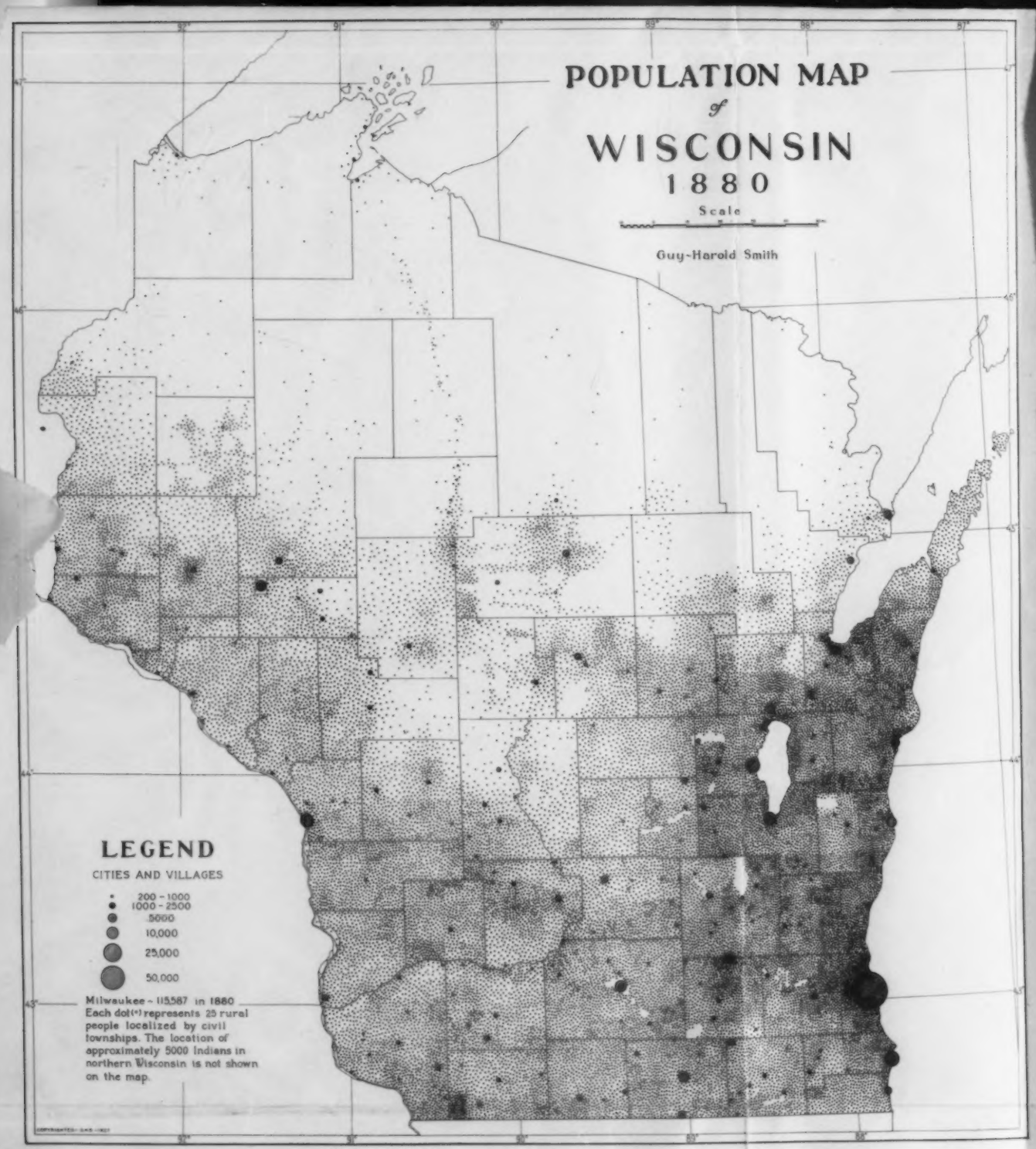
[17] R. H. Whitbeck: The Geography and Industries of Wisconsin, *Wisconsin Geol. and Nat. Hist. Survey Bull. No. 26, Educ. Ser. No. 3*, 1913, p. 20.

The American Geographical Society of New York

POPULATION MAP
of
WISCONSIN
1860
Scale
Guy-Harold Smith
LEGEND
CITIES AND VILLAGES
200 - 1000
1000 - 2500
5000
10,000
25,000
50,000
Each dot(•) represents 25 rural people localized by civil townships. The location of approximately 7000 Indians in northern Wisconsin is not shown on the map.

The Geographical Review, Vol. XVIII, No. 3, 1928. Pl. III



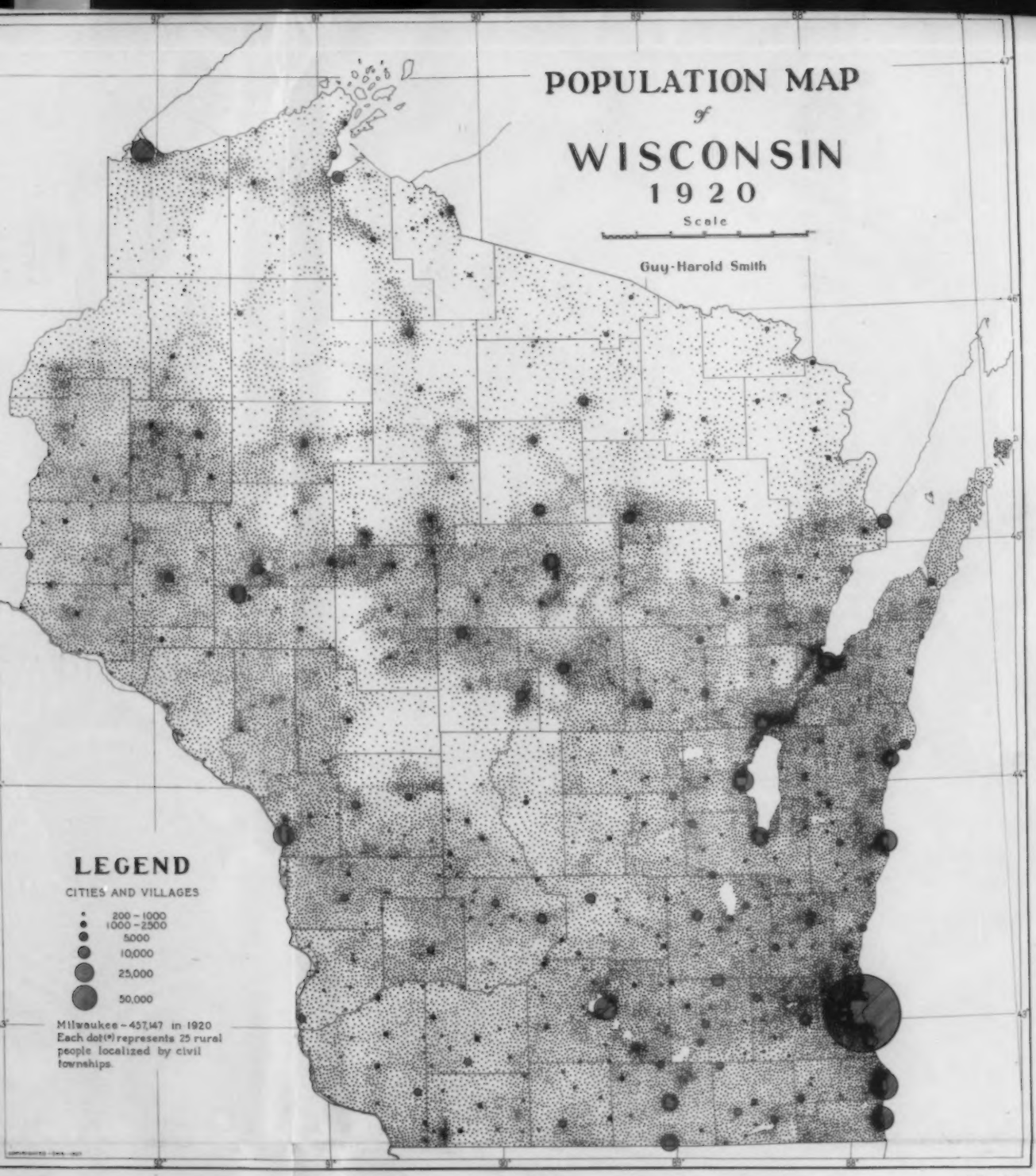

POPULATION MAP
of
WISCONSIN
1880
Scale
Guy-Harold Smith
LEGEND
CITIES AND VILLAGES
200 - 1000
1000 - 2500
5000
10,000
25,000
50,000
Milwaukee - 115,587 in 1880
Each dot(•) represents 25 rural people localized by civil townships. The location of approximately 5000 Indians in northern Wisconsin is not shown on the map.

POPULATION MAP
of
WISCONSIN
1900
Scale
Guy-Harold Smith
LEGEND
CITIES AND VILLAGES
200 – 1000
1000 – 2500
5000
10,000
25,000
50,000
Milwaukee – 285315 in 1900
Each dot(•) represents 25 rural people localized by civil townships.

POPULATION MAP
of
WISCONSIN
1920

Scale

Guy-Harold Smith



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Northern Wisconsin is a mosaic of various types of soil with patches of land of high intrinsic value located between, and in some places surrounded by, extensive sandy or rocky areas unsuited for agricultural development. The northward movement expended itself on the settlement of the sedimentary portion of Wisconsin and the southern segment of the crystalline highland.

The eight counties that occupy the crescent-shaped area along the southern border of the Northern Highland have a total area somewhat less than the remainder of the region. However, there is an outstanding difference in the number of people in the two areas. In 1880 the border counties had a total of 89,516 as compared with the 11,710 for the more northern counties; by 1900 the population in the border counties had increased to 222,790 and the northern counties to 161,698; and in 1920 the larger and more northern area was approaching the 293,452 of the border counties but still fell several thousand short with 260,743 inhabitants. The rapid growth of the population along the edge of the crystalline upland is reflected in the increase of land in farms and a concomitant increase in improved land (Figs. 25 and 26).

Around the crescent-shaped border of the Northern Highland the woodland is being requisitioned for farm land. The value of the northern lands has been grossly overestimated; but a truer valuation deserves to be more widely circulated among prospective home seekers than it has been. It is estimated[18] that "forty per cent of our cut-over land is unsuited to farming . . ." Progress northward will continue but should be guided by an intelligent selection of farm land that leaves the poorer areas for forests and resorts.

[18] B. G. Packer and Oscar Gunderson: Preliminary Biennial Report of the Wisconsin Department of Agriculture, Immigration Division, Madison, 1923–1924. p. 45.

A POPULATION MAP OF OHIO FOR 1920

Guy-Harold Smith

The Ohio State University

[With separate map, Pl. IV, facing p. 426]

THE method of representing distributional phenomena by dots is common enough to make an additional effort seem commonplace. But the accompanying map of Ohio, based on the census of 1920, is more than a dot map. The writer has attempted, by the use of a sphere-like symbol, to show not only the distribution but the concentration of people in compact communities. The experiment is not a new one, for Sten De Geer has used the same method in his population studies in Scandinavia.[1] He used dots to show both the distribution of the rural inhabitants and the location of the small urban communities. The latter were distinguished from the former by the symmetrical arrangement of the dots. This made it easy to determine approximately the population of the smaller towns. The larger cities were represented by appropriate symbols so shaded as to resemble spheres. This is the device borrowed by the writer and modified in the making of the Ohio map.

Construction of the Map

In the formula for the volume of a sphere, $\frac{4}{3} \pi R^3$, the only variable is the radius. This was quickly computed for each symbol by the use of an engineer's slide rule and a proportional scale. The smaller cities and villages were grouped in two diyisions. The United States census regards as "rural" all cities and villages having a population of less than 2500, but on the Ohio map all incorporated places with a population of more than 200 have been shown as urban "agglomerations." As stated in the legend, a small sphere in solid color was chosen to represent all cities and villages having between 200 and 1000. A larger but approximately proportional sphere represents cities and villages having between 1000 and 2500.

All cities of more than 2500 population were regarded as individuals in order to make the symbols correspond more or less exactly with the census data. The larger symbols were drawn in perspective by the use of meridians and parallels. In order to accentuate the

[1] See Sten De Geer: A Map of the Distribution of Population in Sweden: Method of Preparation and General Results, *Geogr. Rev.*, Vol. 12, 1922, pp. 72–83. See also Ellsworth Huntington's review of Sten De Geer's work, *ibid.*, Vol. 9, 1920, p. 360.

optical illusion and make the symbols appear more nearly like spheres, the light was regarded as coming from the upper left or northwest. The lower right or southeastern part of the symbols was darkened to give the effect of being in shadow.

Each of the larger symbols represents an individual urban community, including in most cases the suburbs. But the cities of Cleveland and Cincinnati and their "satellite cities"—shining not only by the reflected economic light of the "parent sun" but by their own light—have been carefully drawn in order to picture the true conditions.

The dots, so called, are to be regarded as small spheres proportional in size to the larger symbols. As stated in the legend, the dots are localized by minor civil divisions. The boundaries are not shown, but a township map was used beneath the original to assist in the localization of the symbols. The topographic maps of the United States Geological Survey were consulted whenever they were found serviceable. Fortunately the Topographic Atlas has been completed for Ohio.

Comparison with the Wisconsin Maps

There have been various criticisms of the three-dimensional symbols; but the principal objection to their use is the real or imaginary difficulty of visualizing comparative volumes. We may ask, however, if the Ohio map, Plate IV, does not convey as true a visual picture of the population conditions in Ohio as do the Wisconsin maps of the population of that state, Plate III (accompanying preceding article). In the Wisconsin series comparative circles were used to represent the cities. This device is quite familiar and is widely used. It is generally more acceptable than the use of the sphere-like symbol because it is a surface device shown on a surface.

The scale used on the Wisconsin map was chosen after a trial-and-error experiment. It seemed desirable to use a scale that would keep the area of the circles comparable with the corporate area of the cities. This, obviously, was impossible; hence it was necessary to compromise. The circles were drawn on a scale that promised to give a fairly accurate picture of the population conditions they were intended to show. By the use of thin lines the circles became transparent discs through which could be shown the boundaries of the larger and important cities and the intensification of the rural inhabitants adjacent to the cities. Because of the inherent difficulty in drawing transparent spheres, this desirable feature of the Wisconsin series of maps could not be used on the Ohio map.

On the Wisconsin maps the areas of the dots used to show the distribution of the rural inhabitants are not exactly comparable with the larger circles. This means that a symbol on one scale was used to depict the dispersion of the rural inhabitants, and the same symbol

on a different scale was used to show the population agglomerations. As on the Ohio map, the dots were localized by civil townships; and the merits of the scheme are obvious.[2]

Rural and Urban Population of Ohio

The active settlement of Ohio began in the last decade of the eighteenth century. The census of 1800 gave a population of 45,365. The population increased rapidly until about 1850 when the rate of increase was slightly reduced for a few decades. In 1840 Ohio attained third place among the states, being exceeded by New York and Pennsylvania. In 1890 third place was relinquished to Illinois, and since then Ohio has been fourth in population. In the decade from 1910 to 1920 Ohio added almost a million to its population, an increase of 20.8 per cent as compared with the increase of 14.9 per cent for the United States as a whole.

This increase, which was due in part to the industrial expansion induced by war conditions, was slightly less than the increase in the urban population alone, which means that there was a reciprocal decrease in the rural population. The position of Ohio between the east and the west and its favorable situation as regards the iron ore and coal resources have contributed to the rapid economic development and the growth of cities.

The first pioneers came into Ohio from the southeast across the rugged plateau; and Cincinnati, strategically situated near the bend of the Ohio River, became an important river town when the Ohio was one of the commercial highways of the Middle West. The city's early lead was not relinquished until near the end of the last century, but by 1920 Cleveland had almost twice as many people as Cincinnati. To these two largest cities in the state can be added five more, each of which had in 1920 a population of 100,000 or more. These seven cities of Cleveland, Cincinnati, Toledo, Columbus, Akron, Dayton, and Youngstown had a combined population of 2,171,635, or 37.7 per cent of the total for the state, a few thousand more than the total rural population.

Even as late as 1890 Ohio was still an agricultural state, but the industrial development was beginning to have its effects upon the rural population. From 1890 to 1900 the rural element in the population declined from 59.0 per cent to 51.9 per cent. At the turn of the century urbanization had not quite succeeded in reducing the rural population to a minority. In 1910, however, the rural population made up only 44.1 per cent, and by 1920 this was reduced to 362. per cent.

[2] Compare Wesley Coulter: A Dot Map of the Distribution of Population in Japan, *Geogr. Rev.*, Vol. 16, 1926, pp. 283–284, and C. E. Batschelet: A Picture of the Distribution of Population in Pennsylvania. *ibid.*, Vol. 17, 1927, pp. 429–433.

Some Features of Regional Distribution

In southeastern Ohio is an extensive area of the Allegheny Plateau that was not covered by the continental ice sheet (Fig. 1). This section is slightly less rugged and more accessible than its remote counterpart in West Virginia and eastern Kentucky. As compared with the rest of Ohio where the relief is slight, the unglaciated plateau is more or less isolated except where lines of communication cross the area. Gallia County, for example, in the extreme southern part of the state, where the ruggedness of the landscape makes agriculture difficult, had in 1920 a total population of 23,311; and 6070 of these lived in the city of Gallipolis, a characteristic river town. In 1880 the maximum population was recorded. Vinton County also reached its maximum in 1880. In 1920 it had only 29.3 rural inhabitants per square mile, the lowest for any county in the state, while according to the census for 1925 it had an agricultural population of but 15.1 per square mile.[3]

The decline in the population in the rural sections of southeastern Ohio cannot be attributed entirely to the industrial expansion and the concomitant urbanization. This was the first part of Ohio to be settled by the pioneers who ascended the northern tributaries of the Ohio River. The better sections were cleared for crop land, but the steep slopes—except where extreme care prevented—were soon gullied and stripped of their soil with the result that the relative value of the land is the lowest in the state.[4] To agriculture itself must be attributed part of the reason for the decline in rural population.

Within the driftless portion of the state there are three or four areas where the density of population is greater than the average. These are mainly the coal-mining areas where the inhabitants engaged in mining are represented by the same sphere-like symbols, which, in effect, fill the interstices between those representing the agricultural peoples. In northern Jackson County is a small coal-mining area; and to the northeastward is the important Hocking Valley area, included within the counties of Hocking, Perry, and Athens. The population map shows a decided increase in density as compared with the surrounding agricultural region. These people are shown as rural, but they are not agricultural. They could not be shown as urban, for they live outside the corporate limit of the cities. The other coal-mining districts are in Noble and Guernsey counties and particularly in Belmont and Jefferson counties. Not only coal mining but the clay-using industries have contributed to the intensification of the non-urban population.

The change in density of the rural population from the driftless

[3] U. S. Census of Agriculture for Ohio, 1925.

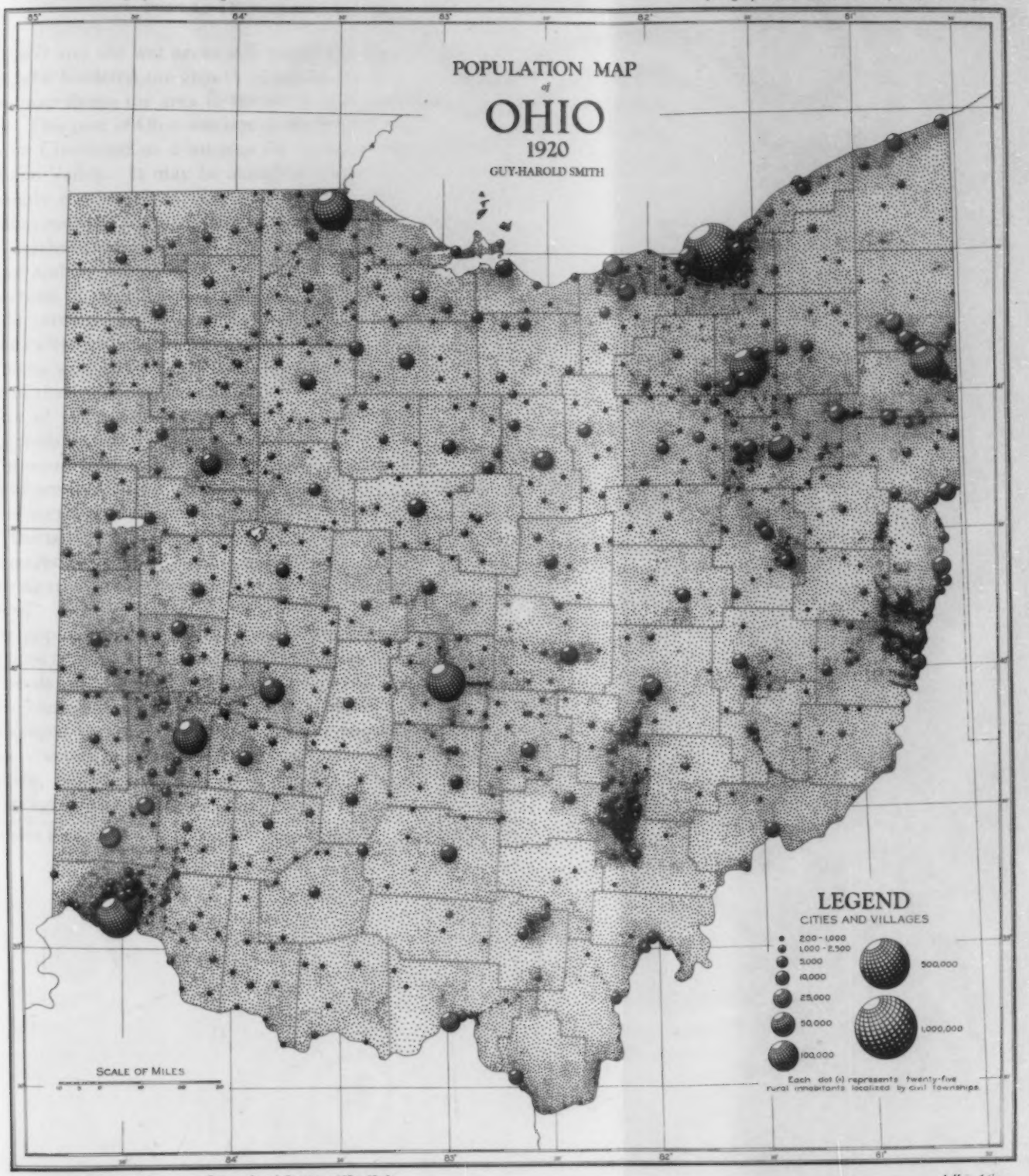
[4] A. E. Waller: The Relation of Plant Succession to Crop Production, *Ohio State Univ. Bull.*, Vol. 25, No. 9 (Contribs. in Botany No. 117), Columbus, 1921, p. 71.

area northwestward into till plains is very gradual.[5] The gradient is difficult to visualize from the map, but it can be demonstrated statistically. In the northeastern part of the state Geauga County lies within the plateau just east of Cleveland. In 1920 the total population was 15,036, or 36.1 per square mile. The highest population was recorded in 1850 when the inhabitants numbered 17,827.

FIG. 1—The physiographic provinces of Ohio: 1, Unglaciated Plateau; 2, Glaciated Plateau; 3, Blue-Grass Region; 4, Till Plains; 5, Lake Plains. (After G. D. Hubbard, *Geol. Survey of Ohio Bull. 27, 4th Ser.*, 1923.) Scale approximately 1:3,750,000.

Morrow County, farther west on the border of the glaciated plateau and the till plains, had in 1860 a total of 20,445, the maximum recorded in any enumeration. Thereafter a steady decline brought the total down to 15,570 in 1920, a decrease of 23.8 per cent in sixty years. To be sure the decrease of the relief westward and northward from the driftless area is more favorable to agriculture, but the patches

[5] Compare A. B. Wolfe: Some Population Gradients in the United States, *Geogr. Rev.*, Vol. 18, 1928, pp. 291–301.



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of poor soil and the wet areas still precluded the full use of the land and thereby hindered the growth of an agricultural population.

The map shows the area to the north of Cincinnati rather thickly settled. This part of Ohio was one of the first sections to be colonized, and from Cincinnati as a nucleus the frontier moved northward up the Miami Valley. It may be stated as a general fact that the older and strictly rural sections were completely occupied by 1880, and in individual counties the maximum was reached even earlier.

In northwestern Ohio lies the extensive plain of glacial Lake Maumee and its successors. The heavy soils of this area and adjacent sections of the till plains, and the reliefless character of the land made the area a vast swamp which retarded settlement. This was the last extensive area to be occupied by the pioneer. The earliest settlements were made along the well drained beaches of the receding waters of these ancient lakes.[6]

Most of the counties in northwestern Ohio did not reach maximum population until 1900 or even later. The counties containing cities of more than 10,000 have in most cases steadily increased, but the rural area reached a static condition about 1900. This area, like all other sections of Ohio, has experienced a decrease in rural population. The only notable exceptions are the zones about the larger cities where market gardening has intensified the use of the land and where unincorporated suburbs have become urban communities in rural territory.

The population map shows Toledo at the focus of a number of radial lines of communication, on which the cities and villages appear like "beads on a string." Along these radial lines and others that traverse the plain a hundred distances between cities were measured and averaged to find the spacing of these community centers. The average distance was found to be 7.3 miles. This number is very suggestive, for it raises the question of how many and how large cities an agricultural region can support.

[6] Roderick Peattie: Geography of Ohio, *Geol. Survey of Ohio Bull. 27, 4th Ser.*, 1923, p. 10.

THE GATHERING OF FLOODS IN THE CONNECTICUT RIVER SYSTEM

J. W. Goldthwait

Dartmouth College

[With separate map, Pl. V, facing p. 444]

THE record-breaking floods of November 3–5, 1927, in New England, directed attention to problems never before fully faced by that region. Human suffering and loss of property in Vermont—and, in lesser degree, in New Hampshire—were promptly met by organized relief and reconstruction, thanks to experience acquired in the greater flood disasters of the Mississippi (1927)[1] and the Miami (1913).[2] In its scientific aspects, however, the New England flood was more of a novelty, for hitherto there had been no close, detailed study of a flood in a country with just that type of irregular glaciated surface. The systematic gathering and discharge of flood water in a simple, well organized river system like the Miami is necessarily different in kind as well as in size from the haphazard, disorderly behavior of an ungraded river system like the Connecticut. Partly because of this, and partly because the 1927 flood was so destructive as to warrant more than the usual analysis, as a measure of protection from future floods I undertook, as geologist of the New Hampshire Highway Department, to collect physical data and to carry on field studies in selected areas. Meanwhile, other organizations—railroads, power companies, groups of civil engineers, and meteorologists, each with a special emphasis and point of view—started investigations into the causes and consequences of this great flood. Some of the results obtained by the Highway Department have already been published in outline.[3] Other studies growing out of them are just beginning. The present paper is a brief discussion of the behavior of the flooded Connecticut River system, the largest of those affected and the one from which flood data have been collected with some fullness and, so far as I know, in a new form.

[1] H. C. Frankenfield and others: The Floods of 1927 in the Mississippi Basin, *Monthly Weather Rev. Suppl. No. 29*, Oct. 18, 1927.

[2] See series of reports published by the Miami Conservancy District, Dayton, Ohio, 1917–1921, particularly: The Miami Valley and the 1913 Flood, by Arthur E. Morgan; Rainfall and Runoff in the Miami Valley, by Ivan E. Houk; and Storm Rainfall of Eastern United States, by the Engineering Staff of the District.

[3] J. W. Goldthwait and R. J. Lougee: Some Characteristics of Northern New England's 1927 Flood, *New Hampshire Highways*, Vol. 5, No. 9, Dec., 1927, pp. 1–6.

R. J. Lougee: Floods in New Hampshire, *New Hampshire Highways*, Vol. 6, No. 1, April, 1928, pp. 12–16; *idem:* Six Historic Floods, *ibid.*, Vol. 6, No. 2, May, 1928.

Distinctive Features of Drainage in New England

The irregularity of the surface traversed and drained by the Connecticut River and its neighbors can be fully appreciated only by those who know New England. While most river systems look like the trunk, branches, and stems of a maple tree or elm, the drainage pattern in New England, and especially in New Hampshire, is more like that of an old apple tree in a deserted orchard—a gnarled trunk, twisted limbs, many withered branches, and here and there a sturdy offshoot or graft that entirely destroys the balance of the design. Headwater basins are diverse in size, shape, and space relationship. Gradients are variable and unrelated—a confusion of rapids and still waters, falls and lakes, bogs, ponds, and wide intervales. Floods gathering in such a country are subject to innumerable and unlike delays from start to finish. What happens on one tributary may be quite different from what happens on the next; and even the main river is likely to respond to a single storm with a flood that is not just a single rise and fall, but a series of waves of differing strength. The progress of any given flood crest down a branch or trunk is of course quite uneven in rate.

The effects of irregularity of slope are supported and magnified by the patchy, heterogeneous character of the mantle of glacial drift. Valleys are generally occupied by thick deposits of silt and sand spread in lakes during the recession of the ice sheet. Early in their history these lakes were drained, as the river systems were revived by uplift. For thousands of years they have been excavating terraces in the old valley filling and are now caught at many points on ledges, upstream from which they swing in oxbows on wide plains or intervales. The upper Coos[4] country between West Stewartstown and Lancaster, and the lower Coos between Woodsville and Bradford are the most extensive natural basins on the Connecticut north of the Massachusetts line. Their broad floors not only afford pondage but, if dry before the flood, soak up a noteworthy amount of water, which is slow to move away. The upland slopes and headwater valleys are occupied by a relatively waterproof blanket of boulder clay, in which a silt matrix, hard packed and full of stones, yields stubbornly to scour by streams. Water runs off quickly and rather abundantly without greatly changing the features. Here and there, where the till has unusual thickness in main or branch valleys, deep gorges have been sawed down since the Ice Age, as at the Fifteen Mile Falls below Lancaster, where a boulder-paved channel occupies the whole bed of the valley.

Before we can understand floods in such circumstances, therefore, or get far in planning flood warnings or other measures of safety

[4] "Coös," or "Cohos," is Indian for flood plain, intervale.

against them we must gather facts in large number, so as fairly to represent the entire drainage basin, and analyze them more critically than would be necessary in the well arranged though at times equally violent river systems of the Middle West and South.

Variable Factors That Combine in Floods

Among the factors that make up the flood equation of a New England river system we may count first of all that typical irregularity of terrain just discussed. Other variables of greater or less consequence are: rainfall, which differs in time of occurrence, duration, and intensity on different parts of the system; snow cover and river ice, which give special emphasis to spring freshets; vegetation cover, which includes diverse types of forest, pasture growth, and cultivated crops and which changes from season to season in capacity for absorbing or delaying run-off; and artificial structures, such as dams, bridges, and buildings touching the stream channel, which influence the flow of water at certain points and may give way under the strain of the flood and impart to it a fresh impulse. Each of these will be briefly reviewed.

RAINFALL

A single storm of wide extent, lasting from 24 to 48 hours and shedding from 4 to 8 inches of rain—or even less than that amount in case the ground is well saturated or well covered with snow—will create a strong flood, or freshet,[5] on the New England streams. Rains of that degree of intensity, spreading over most or all of the area of the drainage basin, occur only when cyclonic low pressure disturbances move over New England, commonly in a direction from south to north or from southwest to northeast. Southward-flowing rivers like the Connecticut get the rain sooner at their lower and middle courses than at their longer and more extreme headwaters. The slender form of the Connecticut drainage basin, its northeast-southwest trend, and the movement of storms up its length rather than down are favorable factors preventing the piling up of the flood.

Knowledge of rainfall in New Hampshire and Vermont is meager and inexact. Concord, Northfield, and Burlington alone are the regular U. S. Weather Bureau stations of New Hampshire and Vermont. Roughly thirty semi-official "coöperative observers" in these two states, and perhaps an additional dozen rain gauges kept by private individuals or power companies, not all reporting their results

[5] The word "freshet," familiarly applied to a spring flood, in which snow contributes to the volume and floating cakes of ice create ice jams and add violence to the flood, appears to have proper use also as applied to autumn floods. It is so used by Belknap, careful historian of New Hampshire in the colonial period, who devotes a page or two of his preface of Volume 3 of the classic "History of New Hampshire" to the discussion of this word as understood in New England.

to the Weather Bureau and so not listed in the Climatological Summaries, bring the total number of rainfall stations in the "twin states" up to possibly 50. Among these, not a single one is on the top or side slope of a mountain. A few, indeed, are situated within five miles of a mountain, for example Glencliff, N. H., and Somerset, Vt.; but most of them represent average conditions of upland and valley and

FIG. 1—Deep gorge cut through sand to rock along a new path by overflow of Black River, Cavendish, Vt. (Photograph by Frank H. Foster.)

give little idea as to how heavy the rainfall may be, and how irregular, on the mountains. Data are too few to serve satisfactorily for the drawing of isohyetal lines. Discordances of rainfall among them are great and rather unsystematic. Casual measurements and impressions as to rainfall on the upper slopes of the White Mountains support the view that it is much heavier there and more frequent than at lower levels. Probably also it is highly irregular in amount and differs in successive storms, owing to the abrupt boundaries and the local and diverse form of these mountain groups and to the differing influence they have on winds coming from different quarters. Records kept at the summit house on Mt. Washington over a period of seventeen years, from 1871 to 1887, indicate an average annual precipitation there of about 82 inches, which is double that of the surrounding country.

In order to find out the facts about mountain rainfall in New Hampshire, arrangements have been made by the State Highway

and Forestry Departments to get daily measurements during the present summer at 50 new stations on and near mountains. This study may show whether floods like that of 1927 are brought about in any considerable degree by excessive rainfall on mountain headwaters. All organizations and agencies that maintain a house, hut,

FIG. 2—The Passumpsic flood at record height. (Photograph by Theodore W. Chase.)

fire lookout, or other station on a mountain in New Hampshire are coöperating in this study.

SNOW COVER AND RIVER ICE

The annual spring freshet of the New England rivers is commonly recognized as the combined product of warm rains and melting snow. River ice "going out" so fast as to jam at gorges and against bridges often aggravates the flood, both by concentrating and raising the wave and by supplying missiles that batter down structures in its path. Storage of winter precipitation in the form of snow is always large in the central Connecticut Valley district and the "north country" and often melts fast when the first warm wave of spring arrives in March or April. The actual thickness and density of this snow cover, however, varies greatly from year to year. Its area is even more variable. The weekly Snow and Ice Bulletins of the Weather Bureau strikingly illustrate this fact. Northern New England is so situated on and near the tracks of storms, which sometimes go north and sometimes south of it, and the 32-degree isotherm fluctuates so far and so often up and down its irregular surface that the ratio of snow to rain in the winter and spring seasons is quite indeterminate. Measurements of snowfall at Hanover since 1834, when plotted in a graph, appear wholly without system.

With a snow mantle whose area, density, and thickness on a given date in spring are sure to differ from those of previous seasons, the arrival of a warm wave whose intensity, area, and duration are also variables creates each year a freshet that always in detail and usually in larger characteristics is different from its predecessors (Fig. 4).

FIG. 3—After the flood at White River Junction.

Twice, at least, spring freshets of more than ordinary strength have been caused by excessive sunshine on lingering snow, without any rain at all. In 1862 one of the highest and worst floods on record in the Connecticut Valley came on April 18–19. The following notes, from contemporary newspapers, are of interest.

The recent flood on the Connecticut River was "one of the most formidable ever known, both as regards the extreme height of the water and the singular circumstances attending it." The river rose fast Saturday and Saturday night and reached at Sunday [the 19th] a "height little exceeded by that of 1854." A toll bridge at South Newbury, Vt., was swept away, and railway trains were stopped at Bradford. There were washouts on the railway along the Passumpsic. Some places on the Connecticut River had high water more than 22 feet above low-water mark (*Vermont Journal*, Windsor, Saturday, Apr. 26, 1862).

"An immense body of snow and ice existed in the northern part of this state [Massachusetts] and through Vermont and New Hampshire, and in many places sleighing over the tops of the fences was the style of traveling most in vogue." At Holyoke, the river stood 12 feet, 4 inches high on the dam, or 9 inches above the record of 1854 [the highest of that century]. At Hartford, Conn., the river had risen 28 feet above low water and was still rising, at 10 a. m. on Sunday, at the rate of an inch an hour. "A bridge on the Northern road at Lebanon [N. H.] is carried entirely away." Rivers all over New England were affected (*Springfield Republican*, quoted, *ibid.*).

A recurrence of this unusual type of flood came in April, 1928. This year, with almost no rain at all and with a cover of snow that

was limited to the White Mountains and the upper Coos districts, a warm wave fully as intense as that of 1862 swelled the upper Connecticut, the lower Ammonoosuc, and the Passumpsic to heights never before reached. At Northumberland, partly because of ice jams, the water stood several feet higher than it had during the great flood of last November. Whitefield, Littleton, and other points on branches that head on the highest White Mountains got a record flood; and even the Passumpsic, with its relatively low upland basin, did more damage than usual in the spring break-up.[6] A large concrete dam at Gilman, below Lancaster, collapsed under the pounding of ice cakes, although it had stood the strain of the November flood five months before.

COVER OF VEGETATION

The distribution of forest, brushy land, open pasture, hayfields, and other types of cover is quite as irregular as the factors already discussed. Here and there in the mountains single summits or groups of summits rise above tree line. A violent and sustained rain on these unclothed mountain sides starts its downhill race with little or no delay. Steep gradient and lack of cover allow the excessively heavy rainfall of the summits to overtake the more slowly collecting run-off of the wooded slopes below. Thus the mountain rainfall has a flood-producing value greater than its actual volume might suggest. The White Mountain area is occupied by forests in all stages of cutting and recovery; but there is mostly mixed growth and brushy woodland. While much of it is scarcely merchantable timber, the foliage and ground carpet probably serve fairly well to delay run-off. The wholesale stripping of the forest on the mountains in the period from 1870 to 1900 has undoubtedly served to increase the tendency of the Connecticut and other rivers to flood,[7] yet it appears that this is largely counteracted by the gain in woodland area on abandoned farms throughout the central and southern parts of the state.

The chief point to be stressed here is, that the cover over the Connecticut drainage basin is very diversified and must be reckoned among the factors that cause different tributaries of the river to deliver floods of different sizes and at different speeds. More concrete and exact study of this factor in New Hampshire is contemplated.

ARTIFICIAL STRUCTURES

Ordinary freshets on the Connecticut and its branches seldom break dams or sweep out bridges; for wherever that has taken place

[6] For a brief account of this see J. W. Goldthwait: The Spring Freshet of 1928. *New Hampshire Highways*, Vol. 6, No. 2, May, 1928.

[7] M. O. Leighton: Floods, in "Papers on the Conservation of Water Resources," *U. S. Geol. Survey Water Supply Paper 234*, 1909, pp. 10–27; particularly pp. 20–22.

the new structure has been more advantageously placed or more strongly built. Not a few of the old covered bridges of New Hampshire and Vermont built between 1830 and 1860 have been set back on their abutments to greater height than the original one, after a flood—especially in 1862, 1866, and 1869; and wherever new bridges have been built they have been placed higher than any known flood mark at that point. In spite of this, scores of bridges were swept away in November, 1927, giving one of the best indications that this flood broke all records for high water, at practically all points, since the middle of the last century. Several hundred bridges went out in the 1927 flood, in Vermont alone, of which perhaps 200 were on the Connecticut system. The headwaters of the White and Ottaquechee rivers suffered most from collapse of dams and washouts of structures bordering the channel. Storage behind a dam first retarded the progress of the flood; then, as pressure became too strong or a washout around one side of it started undermining the structure, the ponded water was suddenly released, forming at that point a flood wave with an unnaturally sharp crest and steep front, which raced downstream threatening to break other dams, one by one, where storage of water from other tributaries was being held in check. Thus an augmented flood wave may have developed, of greater intensity than nature alone would have created. Smaller contributions to height and strength of flood came where mills or bridge foundations gave resistance to the swollen current but finally went out, particularly where bridges banked high with wreckage suddenly gave way, like an ice jam in an early spring freshet.

Just how much of the violence of the November flood on Vermont tributaries was due to weakened dams and other structures along the river system and just how far downstream from a given point the effect of a break or washout reached cannot be stated; but reports of the time of peak flood include both statements and opinions regarding delay or acceleration of the flood from this cause. Obviously, this is a factor that played a greater rôle on the small streams than on the larger ones; for few of the modern power dams on the main lines of drainage went out, while many old milldams in the headwater districts collapsed. This accounts for some of the discrepancies in time of high water shown in the western part of the map (Pl. V).

Ordinary and Extraordinary Floods

High water in the Connecticut system comes definitely twice each year, in spring and fall, in response to the spring and fall rains. When summer precipitation is heavy, it is too local in character and too much delayed by the vegetation cover to build up a vigorous flood on the main river. Midwinter storms likewise rarely produce floods.

TABLE I—HISTORIC FLOODS ON THE CONNECTICUT RIVER

YEAR	SEASON	COMMENT
1771	Fall	Possibly given prominence because it was the first one to cause suffering and damage to settlers in the lower Coos, near Bradford, Vt. (Grant Powers: Historical Sketches of the Discovery, Settlement, and Progress of Events in the Coos Country and Vicinity, Principally Included Between the Years 1754 and 1785, Haverhill, N. H., 1841, pp. 112–114.)
1775	Oct. 20–22	At Charlestown, N. H., higher than for 30 years at this season. Followed three days of rain. (Journal, manuscript, of Enos Stevens at Charlestown. Original in possession of Mr. Henry N. Stevens of London, Eng. Copy now in Town Clerk's office at Newbury, Vt.) Flood not so bad on Wells River at Boltonville; for grist mill there was completed and set running on Oct. 28, 1775, indicating that the mill dam could not have been carried away. (Journal of General Whitelaw, quoted in History of Newbury, Vt., by F. P. Wells, p. 66.)
1785	October	A great freshet throughout New England, with 9 inches of rainfall reported in some places.
1801	Mar. 17–21	The "Jefferson flood." Highest since 1692 at Hartford, Conn., where it registered 27.5 feet. Higher than for 20 years at Keene, N. H.
1824	Feb. 10–13	Highest for 60 years at Bellows Falls, where it stood between 25 and 30 feet above low water. All bridges over the Black River reported gone. Green at Woodstock, Vt., completely inundated. Bad ice jams.
1826	Aug. 28–29	Torrential rain in White Mountains. Landslides at Willey Brook and many other points. Ammonoosuc River at Bretton Woods reported to be 16 feet above normal.
1828	Sept. 3–5	(Cf. record of 1862 flood.) Water at Windsor, Vt., reported 20 feet above normal.
1841	Jan. 8	Highest since 1801 at Hartford, Conn. (26.3 feet). Much damage to bridges at Lebanon, N. H., Hanover, Fairlee, Bradford, Wells River, and along the lower Ammonoosuc. Caused by rains on heavy snow cover.
1854	May 4–7	The "Nebraska flood." Said to be "not paralleled for at least 50 years." Fully as high as the flood of 1801, at Springfield, Mass.
	Apr. 18–19	The "Secession flood." Caused wholly by quick thaw of dense, thick snow cover over all Vermont, New Hampshire, and northern Massachusetts. At Holyoke, Mass. reached point 9 inches higher than flood of 1854 (12.5 feet on gage). Never since equaled. At Bellows Falls, 22 feet above low water. Swept away toll bridge at South Newbury, Vt.

Year	Season	Comment
1866	Mar. 3–4	Strong spring freshet of usual rain-thaw-ice-jam type, particularly destructive near Windsor, where the Cornish toll bridge went out.
	Apr. 25	Another bad flood, destroying many dams and bridges on the Passumpsic.
1869	Oct. 2–5	The best-remembered flood of this generation, prior to 1927. Locally higher and more destructive than that, but in the great majority of places inferior to it. 7-to-8-inch rainfall at Concord, N. H., 6.07 inches at Hanover. About a foot lower than the flood of 1862 at Bellows Falls and Vernon. Well recorded at many places by spikes in trees and other markers.
1878	Dec. 11	Heavy flood at Brattleboro. Highest since 1854 at Hartford, Conn.
1895	Apr. 15–17	9 feet lower than the flood of 1927 at Brattleboro; 7 feet lower than that flood at Bellows Falls; but definitely one of the high floods.
1896	Mar. 1–3	Somewhat lower than that of 1895 yet, like it, properly included among the high floods. This and the preceding one were much more severe on the Merrimac River.
1913	Mar. 28	Approximately the same height as that of 1895 at Bellows Falls and Brattleboro. Reported 30 feet on the gage at White River Junction.
1922	Apr. 12–14	High water 26.8 feet at White River Junction. Took out a bridge at Woodsville, N. H.
1927	Nov. 3–5	Highest records everywhere on the system, except locally on small branches and in the extreme north country. 8 inches above the mark of 1869 on Newbury, Vt., meadows. 5.7 feet above the record of 1869 at Bellows Falls.

February, particularly, is free from floods, probably because of the generally low temperatures and blanket of snow and the improbability of a sustained thaw and warm rain lasting over a period of days. The two maxima of flood occurrence come in early April and middle October (Fig. 4). Because the spring floods are fed largely by snow accumulated during the preceding winter, they are commonly much higher and stronger than the fall floods. Because of variability in snow cover, temperatures, and rainfall also they are more diverse and complex than those of fall (Fig. 4). Extreme floods have occurred, nevertheless, at both seasons. The great fall floods of 1775, 1785, 1828, 1869, and 1927 were as high as the spring floods of 1801, 1824, 1896, and 1913. This means, perhaps, that the fall rainstorms are heavier—tropical cyclones that have come along an inland path, with more moisture and higher temperatures than the "lows" from

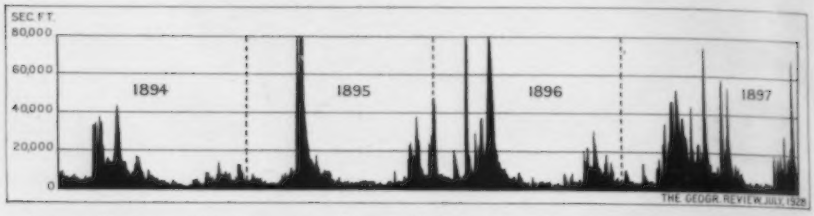


FIG. 4—Discharge of the Connecticut River at Holyoke, Mass., for the years 1894–1897. Characteristics shown are: a spring and a fall flood every year; flood discharge from 10 to 20 times low-water flow; diversity in floods, especially those of spring, as illustrated by the several small freshets of March and April, 1894, the single big freshet of April, 1895, the strong freshets of March and May, 1896, and the prolonged fluctuations of high water from March to July, 1897. (From *U. S. Geol. Survey, 20th Ann. Rept.*, 1899, Vol. 4, Fig. 11 on p. 77.)

the interior—or that the run-off is more rapid on bare ground than on a snow cover.

In the accompanying list (Table I) are all the freshets on the Connecticut River since 1771 that are known to have greatly exceeded the ordinary high waters of spring and fall. Single branches or groups may have had local floods at other dates. Figure 5 shows the distribution of these floods by months. Although the number of cases is not large, the two maxima on this curve signify the same seasonal distribution as that shown in Figure 4. A similar curve has been found for 37 floods that affected New England as a whole.[8]

THE FLOOD OF NOVEMBER 3–5, 1927

The flood of last November is not only the greatest fall flood on record in New England but is the equal probably of any other flood at any time of year in New Hampshire and Vermont. The flood of 1692 can hardly be compared with it, because knowledge of that flood is limited to the lower stretches of the river below Hartford, Conn. Like other fall floods, this one is a direct response to a rainstorm of unusual intensity and duration, drenching ground that was already soggy in headwater districts and passing into the stream channels so promptly and rapidly as to overflow them at their very extremities. Pools and temporary ponds developed in unfamiliar places. Wide sheets of water overspread high-level intervales like those at Crawford's and Bretton Woods under Mt. Washington. Thence these hundreds of little tributary floods raced down their converging courses, expanding on flood plains, crowding through bottle-neck gorges, piling up on dams, and combining, two by two, until they reached the main stem in the form of well organized waves, steeper in front than in back. The particular manner in which these diverse tributary floods of the Connecticut system gathered, moved forward, and combined will now be reviewed.

[8] Lougee, *op. cit.*, figure on p. 14.

During the two or three weeks before this flood all foliage had fallen from the trees; so the rain lost no time in reaching the ground. If the leaf carpet acted as a detaining agency, this soon ceased; for the soil and subsoil were already soaked. No measurable amount of snow had fallen anywhere in the drainage area unless on the mountains; and there was no ice in the streams.

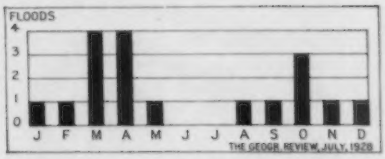


FIG. 5—The occurrence, by months, of extreme floods on the Connecticut River since 1771. Compare Table I.

THE RAINSTORM IN NEW ENGLAND

Moving up the coast of the Carolinas, a tropical "low" left its ocean track, because of high pressure athwart it, in New England and the Maritime Provinces, and came inland, over Long Island and Connecticut, heading straight for the Connecticut Valley.[9] As the warm moist air in this "low" was driven against the upland ridges of the Berkshires and the Green Mountain Range and rode higher and higher over stagnant masses of cold air left by the "high" in the lee of these ridges, rain formed rapidly and fell in torrents, first over Connecticut, then western Massachusetts, and then Vermont and New Hampshire. Within 36 hours a month's rainfall had descended on Vermont and parts of the adjoining states. Although isohyetal maps of this rainstorm have been made they give an inadequate picture of it; for the measurements are limited to stations in valleys and on hills of moderate altitude. There were no observations on mountains, and the intensity of the mountain rainfall can only be guessed from reports like the following.

The rain at Randolph [N. H.] was all Nov. 3rd and 4th. I do not think there was any on Nov. 5th. The rain began in the morning of Thursday, Nov. 3rd, and continued all day except about one hour in the afternoon. The air was warm (perhaps 60° F.), and the wind was south and blew rather hard at times—unusual for south winds at Randolph. The intensity of rainfall was not extraordinary, and the Moose did not rise more than is usual in all-day rains. In the night the rain and wind increased, and when it was light enough Friday morning we saw that the Moose was higher than we had ever known it before. The rain continued, rather hard, till about noon, and then was intermittent for the rest of the day. The air was warm all day. The wind was southeast, east, northeast, and for a short time in the afternoon blew from the north. Before dark the lower clouds broke away so that we could see almost to the summit of Adams. Nine large cascades could be seen pouring down the walls of King's Ravine. Usually, after a storm we cannot see any cascades in King's Ravine from our house.

I am strongly inclined to believe (though I have no positive proof) that the total precipitation on the heights of the Mt. Washington Range was considerably

[9] Compare H. C. Frankenfield: November Floods in New England and Eastern New York, *Mon. Weather Rev.*, Vol. 55, 1927, pp. 496–499. See also H. K. Barrows: Flood Rainfall in New England, *Engineering News-Record*, Vol. 99, 1927, pp. 796–798.

greater than in the valley at Randolph. What we saw when the clouds broke as above described, the fact that it was still raining on the slope of Adams during some of the intermissions in the rain Friday afternoon, the fact that it often rains more on the northern slope of the Range than in the valley and that the summit of Washington is the rainiest place at which records have ever been kept in New England, the unprecedented flood in the Peabody, the great flood in the Ellis, both seeming to point to a very extraordinary rainfall on their respective drainage areas, the great slides brought down from Mt. Washington, Mt. Jefferson and Israel Ridge, and the fact that the rain came from a warm, moist southeast wind, which, it would seem, would deposit most water where most cooled in rising to slide over the heights, are the reasons which lead me to this belief. . .

. . . An open box was left here the day before the storm, and the day after the storm 7 inches of water was found in it. While this is not a standard measurement of rainfall, it seems likely to be approximately correct, or else too small, as we do not know how much water leaked from the box before it was measured. (Letter from Louis F. Cutter, Civil Engineer, Salem, Mass., and Randolph, N. H.)

At Bemis Station, or "Notchland," in Crawford Notch, Mrs. Florence Morey reports that a pail that was empty before the rain Thursday was full to overflowing Friday morning, indicating at least 8 inches rainfall in that short time. At Lost River Cabins, in Kinsman Notch, an empty barrel, according to observations of Mr. Michael E. McCarthy, gathered 14 inches of water during the storm. This is the largest amount reported anywhere, so far as I know. It may be that these large figures are no greater, in proportion, than the usual excess at the places mentioned, which are all situated where mountain ranges may act as funnels against driving storms. They serve at least to emphasize the part played by mountain rainfall in swelling the headwaters and suggest that a region as rugged and irregular as the White Mountains gets far more heavy precipitation than is usually shown on isohyetal maps.

The rain was far ahead of the center of the storm, as it came northward. The heaviest rain in southwestern and central Vermont came on the afternoon and evening of November 3, when the storm center was off New Jersey, well south of Long Island[10] and reached the Passumpsic Valley and the north country early Friday morning, when the center was over southern Connecticut. Exact measurements of irregularity in precipitation from hour to hour are few and scattered. The record at Northfield (Fig. 6) is the best. There, as elsewhere at headwater points, the crest of the flood came very soon after the rain began to let up. Reports from Randolph, N. H., and several places in southeastern Vermont agree on this. Certain flashy streams rose and fell twice, in response to two maxima in intensity of rainfall. Probably some discrepancies in reports are due to double rainfall maxima with observations only of the earlier peak.

[10] J. H. Weber and C. F. Brooks: The Weather-Map Story of the Flooding Rainstorm of New England and Adjoining Regions, Nov. 3 and 4, 1927, *Journ. New England Water Works Assn.*, Vol. 42, 1928, pp. 91–103.

THE FLOOD FROM THE WHITE RIVER

Owing partly to the movement of the rainstorm over the long drainage basin and still more to the differences in shape, size, and gradient of the main branches of the Connecticut, the gathering of floods into the trunk river was highly irregular. All of the Vermont branches as far north as the White River had collected their floods and were having the peak stage far down their courses by midnight, on Thursday–Friday, Nov. 3–4. The series of floods from these Vermont basins poured in in the order of their position on the map. The prompt discharge of floods from the Vermont side is a striking contrast to the slow and odd behavior of the New Hampshire tributaries—the Ashuelot, Cold, and Sugar rivers. These drain areas of gentler gradient, where detention basins are larger and more numerous and irregularity is great. The New Hampshire floods came slowly, reaching the Connecticut from four to twelve hours after those from Vermont.

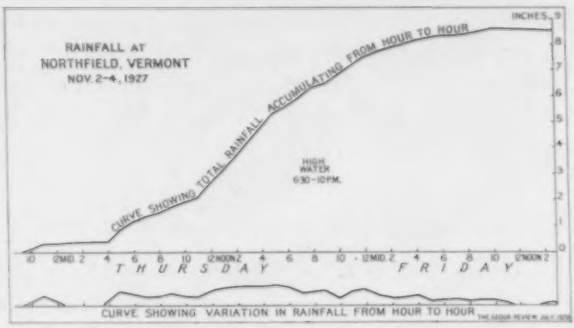

RAINFALL AT
NORTHFIELD, VERMONT
NOV. 2-4, 1927
INCHES
CURVE SHOWING TOTAL RAINFALL ACCUMULATING FROM HOUR TO HOUR
HIGH WATER 6:30-10 P.M.
10 12MID 2 4 6 8 10 12NOON 2 4 6 8 10 12MID 2 4 6 8 10 12NOON 2
THURSDAY
FRIDAY
CURVE SHOWING VARIATION IN RAINFALL FROM HOUR TO HOUR

FIG. 6—Rainfall at Northfield, Vt., Nov. 2–4, 1927. The upper curve shows the total rainfall accumulating from hour to hour; the lower curve the variation in rainfall from hour to hour. (From the report of W. A. Shaw, U. S. Weather Bureau observer.)

While the rain on southeastern Vermont was quickly passing down the system into Massachusetts and while the tributary floods from the New Hampshire side were maneuvering independently, two Vermont tributaries of outstanding importance, the Ottaquechee and White rivers, collected and delivered a deluge which operated along the whole length of the Connecticut Valley below White River Junction as one great unit. These two tributaries more fully than the others gather drainage by convergence of several secondary branches in roughly circular basins, which means that several floods coming down the secondaries arrive almost synchronously and pile up in a sharply defined flood instead of being prolonged and flattened. As the White River has the largest single basin that discharges into the Connecticut system and as its flood built up on top of the floods from the Ottaquechee and more southerly branches, this wave that made the high-water record from White River Junction down to Vernon may properly be called the White River flood. In the damage which they caused, the Vermont branches quite overshadowed those of southwestern New Hampshire; not so much, it seems, because of

greater rainfall as because of better organized run-off along their converging secondaries and their relatively steady gradients and narrow valleys. They are comparatively free from both natural and artificial storage basins.

The best contrast in tributary floods is between the White River and the Mascoma, which come into the Connecticut from opposite sides at White River Junction. The Mascoma is a complex little system in itself, with ponds at many of its sources and marshy intervales at others, as well as one good-sized lake halfway down its main stem. All these are subject to control by dams. So, although this river drains the side slopes of Mt. Cardigain, Smart's Mountain, and Moose Mountain, the flat gradients and easily flooded intervales just downstream from them, together with the ponds, greatly delayed the arrival of floods from the upper half of the basin and threw them out of synchronism.

THE FLOOD FROM THE PASSUMPSIC-AMMONOOSUC SEGMENT

Above White River, the flood on the Connecticut was derived chiefly from the basins of the Passumpsic and Lower Ammonoosuc, with small accessions from the Wells, Ompompanoosuc, and other rivers. Most of the first-order tributaries in this district are short. The drainage basin of the Connecticut for nearly forty miles is narrow, with the watershed at one place, on the east side of it, only six miles away. The Connecticut, for fifteen miles or more, in this "lower Coos" district, winds in great oxbows on a flood plain more than a mile wide. Here the floods from the Wells, Lower Ammonoosuc, and Passumpsic rivers collected, arriving at Woodsville about six hours apart, at 8 a. m., 3 p. m., and 8 p. m. Rainfall over the Passumpsic basin was no heavier than elsewhere in this part of New Hampshire and Vermont; but the concentration of run-off created a greater flood here, as it has done many times before. It took the Passumpsic flood about five hours to make its way down the Connecticut Valley from East Barnet to Woodsville and to build up behind the floods already gathered there from the Wells and Lower Ammonoosuc rivers to a maximum stage. Thence, like the White River flood, this Passumpsic wave flowed down the valley leaving high-water marks never before equaled and not approached when the flood from the upper Connecticut or north country came through almost two days later. At Newbury, on the lower Coos, the water overspread the intervales, rising slowly until it stood eight inches higher than the well-recorded mark of 1869 and making a lake ten to twenty feet deep and from one to two miles wide. The pondage here is enormous and accounts largely for the construction of a single symmetrical flood wave out of the three contributing basins above

Woodsville. It advanced at the rate of about two miles an hour and arrived at White River Junction 34 hours after the White River flood had left.

THE FLOOD FROM THE UPPER COOS OR NORTH COUNTRY

The third flood which gathered in the upper reaches of the Connecticut system was later, flatter, and slower than either of the others. The map (Pl. V) shows in outline how freakish and how different in size these northern branches are. It cannot, however, express adequately the oddity and diversity of the country around these streams. Some drain rugged mountain slopes, some lie almost wholly in low ground, with ponds, lakes, and swamps interrupting the flow. More of this country is forested than farther south.

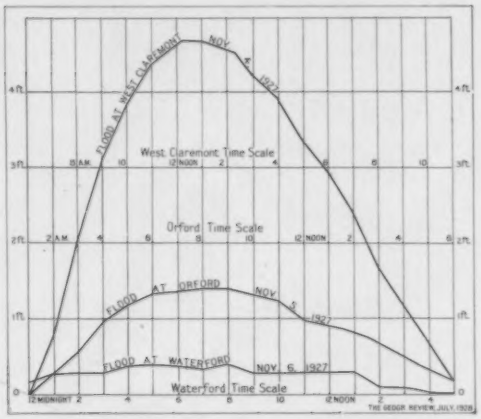


FIG. 7—Rise and fall of the November, 1927, flood on the Connecticut River as measured hour by hour at three points: (1) flood from the White River, measured by Roy D. Hunter at West Claremont, peak noon of Nov. 4; (2) flood from Ammonoosuc-Passumpsic, or Lower Coos, region, measured by W. R. Harris at Orford, peak morning of Nov. 5; (3) flood from north country, or Upper Coos, region, measured by New England Power Construction Co. at Waterford bridge, peak morning of Nov. 6.

The vertical scale is the same for the three cases; but the crests of the floods are plotted one above the other for ease of comparison. Only the peak portion of the Waterford curve is shown. This long flat wave took five days to rise four and a half feet to its peak and fall again, while the flood from White River rose and fell that amount in less than 18 hours.

Floods from tributary basins in this north country are almost sure to fail to synchronize, yet pondage on the intervales from West Stewartstown south to Lancaster and Gilman dam tends to unite these floods before they move down the long gorge of the Fifteen Mile Falls to the Passumpsic. The New England Power Company's measurements at Waterford bridge, halfway down the Fifteen Mile Falls, show a surprisingly prolonged rise of water for 36 hours, which reached its flat peak from four to eight o'clock Sunday morning. The fall of the flood was equally slow and steady. So, we find the third flood wave originating in the north country, becoming simplified and elongated in the meadows of the Upper Coos, gathering speed on its way down the gorge of Fifteen Mile Falls, but arriving at East Barnet 42 hours after the Passumpsic flood had left that point.

Like three divisions of a great street procession, these three floods moved down the Connecticut Valley, in series and well spaced: the

biggest and fastest coming out of the White River valley at four o'clock Friday morning, the Passumpsic-Ammonoosuc flood coming along 34 hours later, and the flood from the north country, longest, flattest, and slowest, starting 42 hours behind the second one.

The Need for Study of Future Floods

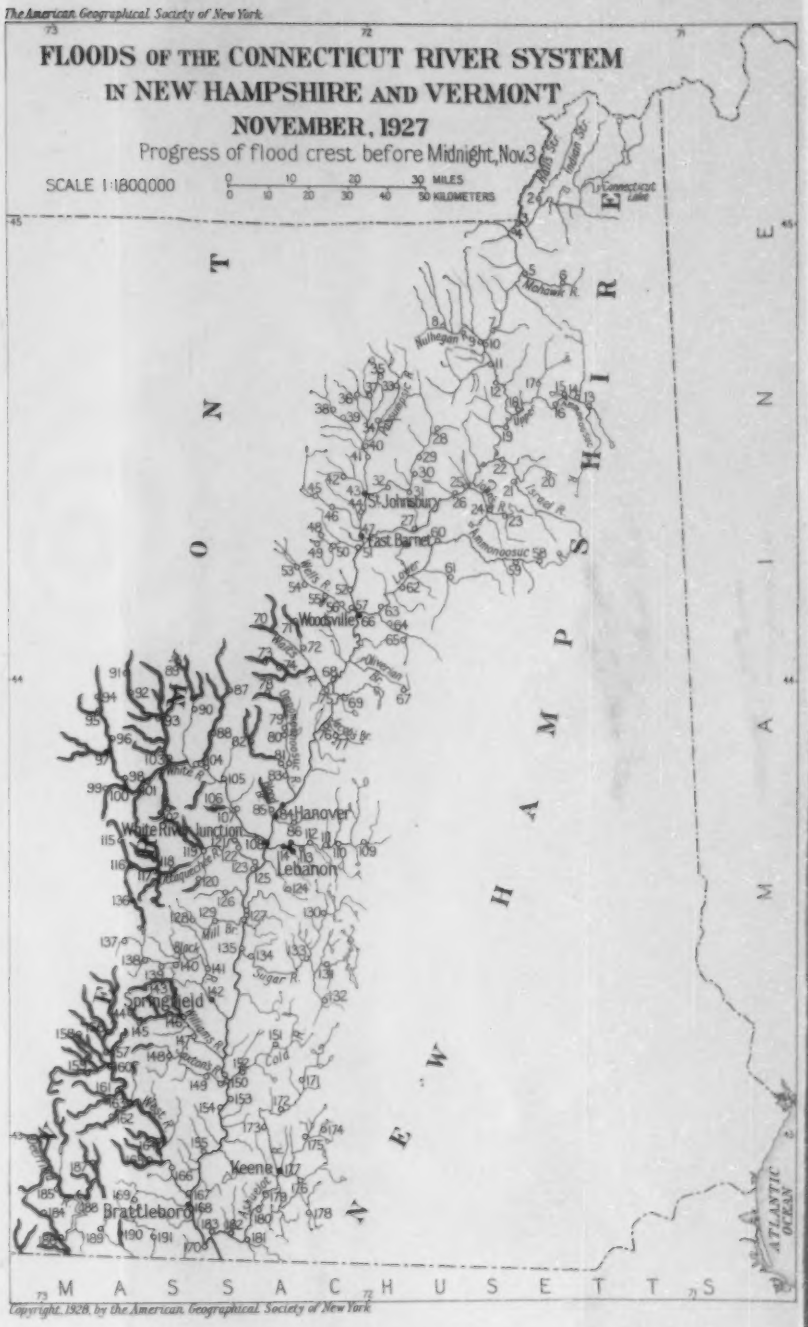
The threefold division of this great flood of November, 1927, on the Connecticut River is probably a typical feature, likely to be seen almost every time a major flood comes down through the system; for the drainage basin itself has three distinct parts. Variants from this type are sure to come, however.

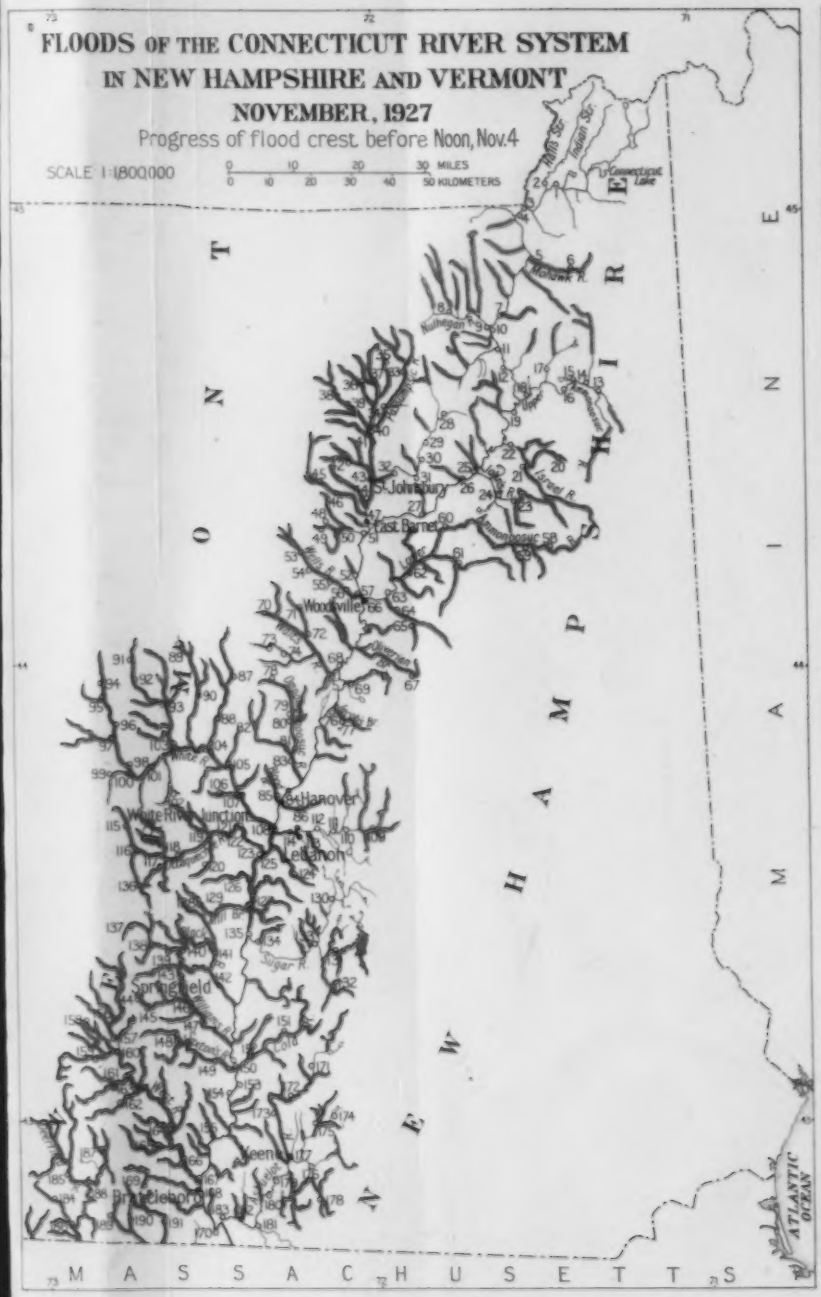
Minor floods on the main river will often originate in a flood of considerable strength gathered by one of its branches or in one of its three main segments. The really high spring freshet of this year (1928) is a case in point. While the 1928 freshet is exceptional in having developed wholly from thawing of the snow cover in the north country and the White Mountains, it emphasizes the fact that those districts above all others in the drainage basin are likely to have a thick cover of snow and to flood in spring when the first sustained warm wave—accompanied almost always by rain—arrives. Those dwelling along the middle and lower course of the river are accustomed to find it rising to unexpected height at this season in April or early May when no flood-producing rains or thawing snow in the central area had been noticed. Heavy local rains are likely to create floods of all sizes within subdivisions of the system. Summer thunderstorms, sometimes coming a few hours apart over nearly the same path, are their commonest cause. Their effects are almost equally local.

Those floods that have risen highest and done most damage along the main river seem each time to have been gathered from the whole drainage area, when a single great rainstorm advancing northeastward or northward completely overspread it. It is not likely that the direction of movement of such a storm will ever be different from this, which, as remarked, is a most favorable condition for the Connecticut. Rivers of much greater area, like the Mississippi, attain full flood only when visited by successive rainstorms, so placed and timed that the flood that comes down one branch, in response to an earlier storm or series of storms, meets a flood coming down a lower tributary in response to a later one. Such a combination would seem unlikely on a river whose drainage area is as small as the Connecticut; for cyclonic storms, or "lows," are hundreds of miles in area and move at such slow rates across the country that it is unusual for two of them to pass nearly over a limited district within two days of each other. That there is a chance of a combination of this sort, however, is a matter of real concern in preventing damage from future floods.

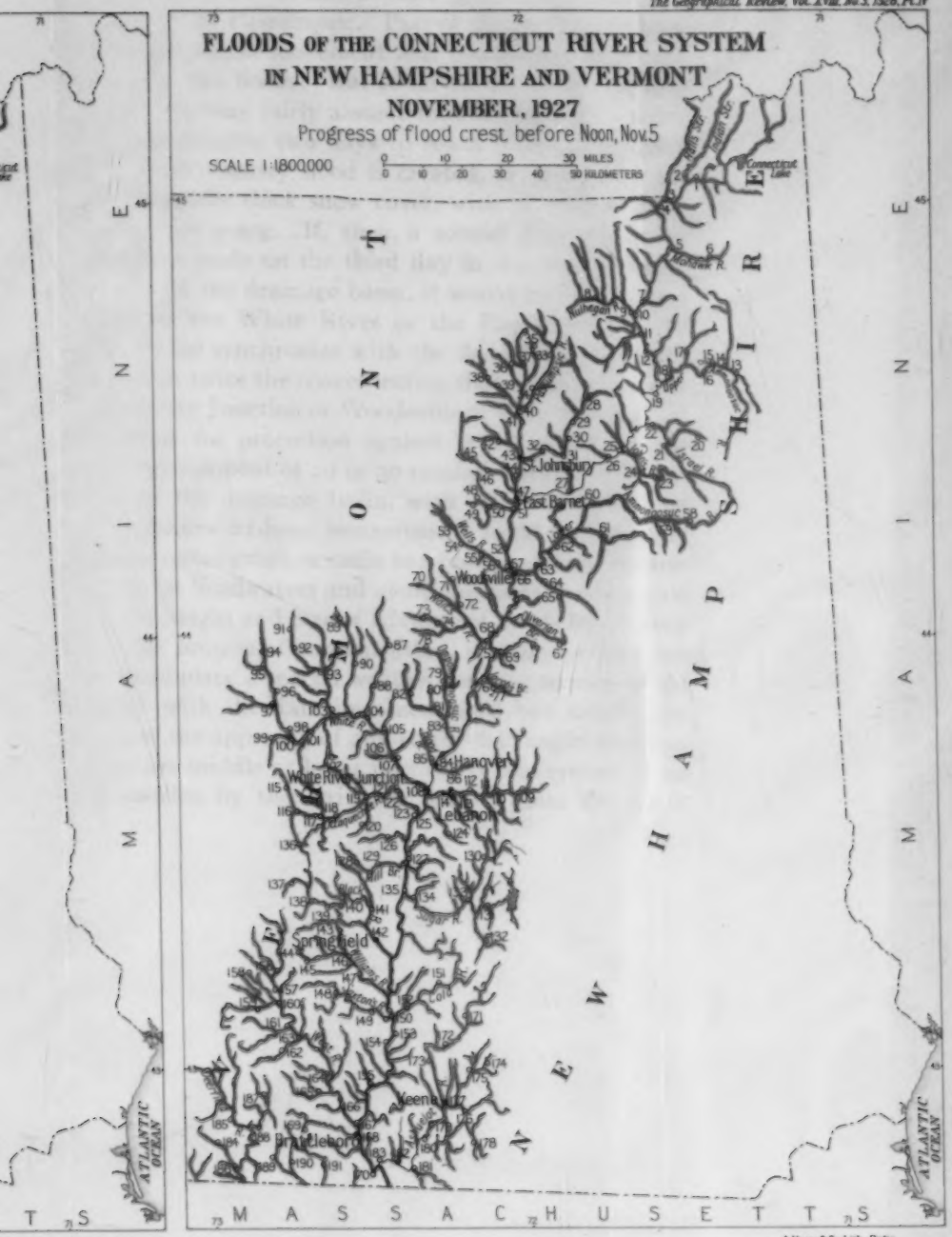
PLACES REPORTING TIME OF FLOOD CREST

	STATION	Nov.
1	Pittsburg—M'dn't	4
2	Indian Stream—10.30 p. m.	4
3	Beecher Falls—M'dn't	4
4	W. Stewartstown—10 p. m.	4
5	Colebrook—9.30 a. m.	4
6	Kidderville—6 a. m.	4
7	Lyman Falls—8 p. m.	4
8	Wenlock—3 p. m.	4
9	Bloomfield—3 p. m.	4
10	N. Stratford—10.30 p. m.	4
11	Brunswick—5 a. m.	5
12	Maidstone—7 a. m.	5
13	W. Milan—2.30 p. m.	4
14	Crystal—8 p. m.	4
15	Percy—9.12 p. m.	4
16	Stark—8 p. m.	4
17	Nash Stream—3 p. m.	4
18	Groveton—2 a. m.	5
19	Guildhall—5.12 p. m.	5
20	E. Lancaster—9.30 a. m.	4
21	Riverton—noon	4
22	Lancaster—1 p. m.	4
23	Hazen's—12-4 p. m.	4
24	Whitefield—3-4 p. m.	4
25	S. Lunenburg—7.30 a. m.	6
26	Gilman—9.30 a. m.	6
27	Waterford—4-8 a. m.	6
28	Granby—7 a. m.	4
29	Victory—8 p. m.	4
30	N. Concord—9 p. m.	4
31	Concord—5 p. m.	4
32	E. St. Johnsbury 10.30-11 a. m.	4
33	East Haven—9 a. m.	4
34	E. Burke—10.30-11 a. m.	4
35	Newark—8-11 a. m.	4
36	Sutton—8-10 a. m.	4
37	W. Burke—6.30-7.30 a. m.	4
38	Sheffield—5 a. m.	4
39	Wheelock—6 a. m.	4
40	Lyndonville—10-10.30 a. m.	4
41	Lyndon—12-12.30 p. m.	4
42	N. Danville—11 a. m.	4(?)
43	St. Johnsbury—12.2 p. m.	4
44	Passumpsic—11 a. m.-3 p. m.	4
45	W. Danville—11 p. m.-1 a. m.	3-4
46	S. Danville—10-10.30 a. m.	4
47	E. Barnet—12-4 p. m.	4
48	Peacham—9 a. m.	4
49	S. Peacham—6-7 a. m.	4
50	W. Barnet—10.15 a. m.	4
51	Barnet—3 p. m.	4
52	E. Ryegate—6-7 p. m.	4
53	Ricker's Mills—1-5 a. m.	4
54	Groton—5 a. m.	4
55	S. Ryegate—M'dn't	3
56	Boltonville—7 a. m.	4
57	Wells River—8 a. m.	4
58	Fabyan's—8 a. m.	4
59	Twin Mt—8 a. m.	4
60	Littleton—10 a. m.	4
61	Franconia—11 a. m.	4
62	Lisbon—10.30 a. m.	4
63	Bath—1 p. m.	4
64	Swiftwater—10 a. m.	4
65	Benton—2 a. m.	4
66	Woodsville (Ammonoosuc R.)—2.3 p. m. (Conn. R.)—6-7 p. m.	4
67	Glencliff—7-8 a. m.	4
68	Bradford (Conn. R.)—M'dn't-7 a. m.	4
69	Piermont—4-5 a. m.	5
70	E. Orange—11.30 p. m.	3
71	Topsham—M'dn't	3
72	E. Corinth—5 a. m.	4
73	W. Corinth—9-10 p. m.	3
74	Corinth—9-11 p. m.	3
75	Bradford (Waits R.)—7 a. m.	4
76	Orford—8-9 a. m.	5
77	Orfordville—6 a. m.	4
78	Vershire—10-12 p. m.	3
79	W. Fairlee—12-6 a. m.	4
80	Post Mills—8-9 a. m.	4
81	Thetford Cen—12-2 a. m.	4
82	Strafford—M'dn't	3
83	Union Village—10-12 p. m.	4
84	Hanover (above big bend)—11 a. m. (Ledyard Bridge)—1 p. m.	5
85	Norwich—1 a. m.	4
86	Greensboro—7 a. m.	4
87	Chelsea—7-8 p. m.	3
88	Tunbridge—9-10 p. m.	3
89	Brookfield—9-9.30 p. m.	3
90	E. Randolph—1-1.30 a. m.	4
91	E. Granville—10-11 p. m.	3
92	Braintree—1-2 a. m.	4
93	Randolph—9 p. m.-9.30 a. m.	3-4
94	Granville—10.30 p. m.	3
95	Hancock—7-8 p. m.	3
96	Rochester—2 a. m.	4
97	Talcville—11.30 p. m.	3
98	Stockbridge—10.30 p. m.	3
99	Pittsfield—1 a. m.	4
100	Tweed River—2 a. m.	4
101	Gaysville—11 p. m.	3
102	Barnard—8-9 p. m.	3
103	Bethel—11.30 p. m.	3
104	S. Royalton (west)—1 a. m. (village)—1.30 a. m. (east)—1 a. m.	4
105	Sharon—1.30 a. m.	4
106	N. Pomfret—M'dn't	3
107	W. Hartford—3 a. m.	4
108	White River Junc—4 a. m.	4
109	Canaan—10.30 a. m.	4
110	W. Canaan—2 p. m.	4
111	Enfield—11 a. m.	5
112	Mascoma—6 a. m.	4
113	Stony Brook—10-12 p. m.	3
114	Lebanon (town)—5 p. m. (mouth Great Br.)—3 p. m. (below Great Br.)—3-4 p. m. (Electric Plant)—2 a. m.	4
115	Sherburne—10-12 p. m.	3
116	W. Bridgewater—2 a. m.	4
117	Bridgewater Cor—11 p. m.	3
118	Bridgewater—11.30 p. m.	3
119	Woodstock—1-2 a. m.	4
120	S. Woodstock—12-2 a. m.	4
121	Quechee—3 a. m.	4
122	Dewey's Mills—3 a. m.	4
123	Evarts—2 a. m.	4(?)
124	Meriden—3 a. m.	4
125	N. Hartland—7.30-8 a. m.	4
126	Hartland 4 Cors—2 a. m.	4
127	Windsor (north)—11.15 a. m. (toll bridge)—11.30 a. m. (Mill Brook)—5 a. m.	4
128	S. Reading—1 a. m.	4
129	Brownsville—1-4 a. m.	4
130	Grantham—M'dn't-noon	4-5
131	Guild—7.45 a. m.	4
132	Mill Village—4 a. m.	4
133	N. Newport—2 p. m.	4
134	W. Claremont (Coy Paper Co.)—11 a. m.-2 p. m.	4
135	W. Claremont (Conn. R.)—1 p. m.	4
136	Plymouth Union—9-11.30 p. m.	3
137	Healdville—2.30-3 a. m.	4
138	Ludlow—3 a. m.	4
139	Proctorsville—2 a. m.	3
140	Cavendish—2 a. m.	3
141	Perkinsville—10 p. m.	3(?)
142	Springfield—7-8 a. m.	4
143	Gassetts—10.30 p. m.	3
144	Weston—12.30-1 a. m.	4
145	Simonsville—8 p. m.	3(?)
146	Chester—2 a. m.	4
147	Bartonsville—11 p. m.-3 a. m.	3-4
148	Grafton—2 a. m.	4
149	Saxton's River—2 a. m.	4
150	Bellows Falls (above dam)—5.30 p. m. (below dam)—7 p. m. (mouth Saxton's R.)—4-5 a. m.	4
151	S. Acworth—7 a. m.	4
152	Drewsville—8.30 a. m.	4
153	Walpole—12.30 a. m.	5
154	Westminster—M'dn't	4
155	Putney—11 p. m.-1 a. m.	4-5
156	Londonderry—10 p. m.	3
157	S. Londonderry—10.30 p. m.	3
158	Peru—6-7.30 p. m.	3
159	Bondville—10 p. m.	3
160	Winhall Sta—11 p. m.	3
161	Jamaica—11.30 p. m.	3
162	Wardsboro—11.30 p. m.	3
163	E. Jamaica—11.30 p. m.	3
164	Newfane—11-11.30 p. m.	3
165	Williamsville—10 p. m.	3
166	W. Dummerston—2 a. m.	4
167	Chesterfield—2 a. m.	5
168	Brattleboro—1 a. m.	5
169	Marlboro (Vt.)—7 a. m.	4
170	Vernon—1 a. m.	5
171	Marlow—1 p. m.	4
172	Gilsum—noon	4
173	Surry—9 a. m.	4
174	Munsonville—7 a. m.	4
175	E. Sullivan—10.30 a. m.	4
176	Marlboro (N. H.)—1 p. m.	4
177	Keene—9.30-10 p. m.	4
178	Troy—4 a. m.	4
179	W. Swanzey—8 a. m.	5
180	Westport—3-4 p. m.	5
181	Winchester—3-4 p. m.	5
182	Ashuelot—9-12 p. m.	5
183	Hinsdale—2-3 a. m.	6
184	Heartwellville—8-9 p. m.	3
185	Searsburg—7-8 p. m.	3
186	Readsboro—9.30 p. m.	3
187	W. Dover—8 p. m.	3
188	Wilmington—11 p. m.	3
189	Jacksonville—2-3 a. m.	4
190	W. Halifax—9-10 p. m.	3
191	GreenRiver—8.45 a. m.	4




FLOODS OF THE CONNECTICUT RIVER SYSTEM
IN NEW HAMPSHIRE AND VERMONT
NOVEMBER, 1927
Progress of flood crest before Noon, Nov.4
SCALE 1:1800000
0 10 20 30 MILES
0 10 20 30 40 50 KILOMETERS
Connecticut Lake
Mohawk R.
St Johnsbury
East Barnet
Woodsville
Hanover
White River Junction
Lebanon
Springfield
Keene
Brattleboro
ATLANTIC OCEAN
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS

FLOODS OF THE CONNECTICUT RIVER SYSTEM
IN NEW HAMPSHIRE AND VERMONT
NOVEMBER, 1927
Progress of flood crest before Midnight, Nov.4
SCALE 1:1800000
0 10 20 30 MILES
0 10 20 30 40 50 KILOMETERS
Connecticut Lake
Mohawk R.
St Johnsbury
East Barnet
Woodsville
Hanover
White River Junction
Lebanon
Springfield
Keene
Brattleboro
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS


FLOODS OF THE CONNECTICUT RIVER SYSTEM
IN NEW HAMPSHIRE AND VERMONT
NOVEMBER, 1927
Progress of flood crest before Noon, Nov. 5
SCALE 1:1800000
0 10 20 30 MILES
0 10 20 30 40 50 KILOMETERS
Connecticut Lake
Pittsburg
Colebrook
Stratford
Berlin
Gorham
Lancaster
Whitefield
Littleton
Bethlehem
Franconia
Woodsville
Wells River
Barnet
St. Johnsbury
Lyndonville
Concord
Manchester
Nashua
Keene
Brattleboro
Springfield
Bellows Falls
White River Junction
Hanover
Lebanon
Claremont
Newport
Windsor
Bellows Falls
Rutland
Burlington
Montpelier
Barre
Northfield
Waterbury
Middlesex
Winooski
Essex Jct.
Richford
St. Albans
Swanton
Enosburg Falls
Fairfax
Milton
Essex
Jericho
Underhill
Hinesburg
Shelburne
Charlotte
Ferrisburg
Vergennes
Middlebury
Bristol
Waitsfield
Warren
Fayston
Moretown
Duxbury
Waterbury
Stowe
Morrisville
Hyde Park
Johnson
Cambridge
Jeffersonville
Lamoille R.
Winooski R.
Mad R.
Dog R.
Passumpsic R.
Wells R.
Ompompanoosuc R.
Waits R.
White R.
Ottauquechee R.
Black R.
Williams R.
Saxtons R.
Deerfield R.
Ashuelot R.
Contoocook R.
Merrimack R.
Israel R.
Upper Ammonoosuc R.
Nulhegan R.
Clyde R.
Barton R.
Willoughby R.
Moose R.
Gale R.
Ammonoosuc R.
Wild R.
Androscoggin R.
Upper Androscoggin R.
Dead R.
Swift R.
Saco R.
Ellis R.
Peabody R.
Israel R.
Upper Ammonoosuc R.
Connecticut

We have seen that the flood that gathered in the upper Coos, or north country, was 42 hours too late, at East Barnet, to synchronize with the strong flood of the Passumpsic. Part of this delay may have been due to northward storm movement and consequent difference in time of origin of the two floods. But so far as that is so, the case is probably normal. We may fairly assume that the crest of a north country flood will take roughly two days to reach Woodsville. Suppose, now, that a north country flood is created, in spring, by the thawing of an exceptionally thick snow cover, with or without rain. It takes two days to get going. If, then, a second flood-producing rainstorm should arrive early on the third day in the southernmost or the middle portion of the drainage basin, it would be just in time to produce a flood on the White River or the Passumpsic or the Ammonoosuc that would synchronize with the flood from the north country and accomplish twice the concentration that came in November, 1927, at White River Junction or Woodsville or East Barnet.

Proper organization for protection against floods might include as a first step the establishment of 20 or 30 rainfall stations at points well distributed over the drainage basin, with some, certainly, on mountains. Any excessive 24-hour measurement could be promptly reported by telephone or telegraph or radio to a central office. Stream-gaging stations, both on headwaters and along the main rivers, would give knowledge of the height and rate of advance of floods from many branches, early in the process of concentration, in time for effective warnings. In the third place a special weather forecast service would not only keep touch with the data just mentioned but would give warning in advance of the approach of any storm that might threaten to create a flood on the middle or lower portions of the system when that was already swollen by the arrival of a flood from the north country.

THE CHANNELED SCABLAND OF EASTERN WASHINGTON

J Harlen Bretz
University of Chicago

[With separate map, Pl. VI, facing p. 476]

NO one with an eye for land forms can cross eastern Washington in daylight without encountering and being impressed by the "scabland." Like great scars marring the otherwise fair face of the plateau are these elongated tracts of bare, or nearly bare, black rock carved into mazes of buttes and canyons. Everybody on the plateau knows scabland. It interrupts the wheat lands, parceling them out into hill tracts less than 40 acres to more than 40 square miles in extent. One can neither reach them nor depart from them without crossing some part of the ramifying scabland. Aside from affording a scanty pasturage, scabland is almost without value. The popular name is an expressive metaphor. The scablands are wounds only partially healed—great wounds in the epidermis of soil with which Nature protects the underlying rock.

With eyes only a few feet above the ground the observer today must travel back and forth repeatedly and must record his observations mentally, photographically, by sketch and by map before he can form anything approaching a complete picture. Yet long before the paper bearing these words has yellowed, the average observer, looking down from the air as he crosses the region, will see almost at a glance the picture here drawn by piecing together the ground-level observations of months of work. The region is unique: let the observer take the wings of the morning to the uttermost parts of the earth: he will nowhere find its likeness.

The Thesis

Conceive of a roughly rectangular area of about 12,000 square miles, which has been tilted up along its northern side and eastern end to produce a regional slope approximately 20 feet to the mile. Consider this slope as the warped surface of a thick, resistant formation, over which lies a cover of unconsolidated materials a few feet to 250 feet thick. A slightly irregular dendritic drainage pattern in maturity has been developed in the weaker materials, but only the major streamways have been eroded into the resistant underlying bed rock. Deep canyons bound the rectangle on the north, west, and south, the two

master streams which occupy them converging and joining near the southwestern corner where the downwarping of the region is greatest.

Conceive now that this drainage system of the gently tilted region is entered by glacial waters along more than a hundred miles of its northern high border. The volume of the invading water much exceeds the capacity of the existing streamways. The valleys entered become river channels, they brim over into neighboring ones, and minor divides within the system are crossed in hundreds of places. Many of these divides are trenched to the level of the preëxisting valley floors, others have the weaker superjacent formations entirely swept off for many miles. All told, 2800 square miles of the region are scoured clean onto the basalt bed rock, and 900 square miles are buried in the débris deposited by these great rivers. The topographic features produced during this episode are wholly river-bottom forms or are compounded of river-bottom modifications of the invaded and overswept drainage network of hills and valleys. Hundreds of cataract ledges, of basins and canyons eroded into bed rock, of isolated buttes of the bed rock, of gravel bars piled high above valley floors, and of island hills of the weaker overlying formations are left at the cessation of this episode. No fluviatile plains are formed, no lacustrine flats are deposited, almost no débris is brought into the region with the invading waters. Everywhere the record is of extraordinarily vigorous subfluvial action. The physiographic expression of the region is without parallel; it is unique, this channeled scabland of the Columbia Plateau.[1]

General Features of the Region

In but few regions of comparable area does a single formation have so great a thickness, possess so nearly intact the original surface, and appear so consistently in the relief features as does the Columbia basalt in eastern and central Washington. The plateau is high where the basalt is upwarped, it is low where the basalt is downflexed, it is rough where the basalt is dissected, and relatively smooth where dissection has not occurred. Its main drainage lines are largely consequent on the structure of the basalt, as are its more prominent divides.

The flows of this great formation were originally horizontal. Now, however, there are but few tracts whose underlying flows are not

[1] The author's previous writings on this subject include: Glacial Drainage on the Columbia Plateau, *Bull. Geol. Soc. of America*, Vol. 34, 1923, pp. 573–608; The Channeled Scablands of the Columbia Plateau, *Journ. of Geol.*, Vol. 31, 1923, pp. 617–649; The Age of the Spokane Glaciation, *Amer. Journ. of Sci.*, Ser. 5, Vol. 8, 1924, pp. 336–342; The Spokane Flood Beyond the Channeled Scabland, *Journ. of Geol.*, Vol. 33, 1925, pp. 97–115 and 236–259; Channeled Scabland and the Spokane Flood, *Journ. Washington Acad. of Sci.*, Vol. 17, 1927, pp. 200–211 (an abstract and a number of criticisms); What Caused the Spokane Flood?, *Bull. Geol. Soc. of America*, Vol. 38, 1927, p. 107 (abstract presenting the idea that subglacial vulcanism may have been responsible); The Spokane Flood: A Reply, *Journ. of Geol.*, Vol. 35, 1927, pp. 461–468 (answering E. T. McKnight: The Spokane Flood: A Discussion, *ibid.*, pp. 453–460); Alternative Hypotheses for Channeled Scabland, *Journ. of Geol.*, Vol. 36, 1928, pp. 193–223; 312–341.

gently tilted or markedly folded. In general, the dip is westward in the eastern part and southward in the western part. Several sharply localized folds occur in the western part, and one in the southeast; elsewhere the warping is so gentle that the terms used for folded structures are not applicable. The drainage pattern faithfully reflects the structure, though it is obvious that not all streams can be consequent.

FIG. 1—Mature topography of the loess. (Photograph by Donald Bell.)

Though the west-flowing Spokane and Columbia rivers skirt the northern edge of the plateau for more than a hundred miles, they receive in this distance the drainage of only about 1300 square miles, so close to their route is the high edge of the gently tilted region. Structure determines the convergence of two-thirds of the entire region's drainage to the Snake and Columbia along its southwestern margin.

Rocks both older and younger than the basalt are elements in the topography of the plateau. The older rocks constitute local elevations, "steptoes,"[2] in the extreme eastern and northern parts of the plateau above the plateau surface. The younger rocks, all sedimentary, are a wide-spread mantle which originally completely covered the basalt. They are composed of piedmont waste, stream gravel, volcanic ash, lacustrine silt, and loess. The loess is much more extensive than all the other deposits. It is deepest in the eastern portion, but in all nearly level parts of the plateau it is deep enough to have been an important item in recording the episode of scabland-making. The essential fact regarding these sediments is that they are all much less resistant than basalt to erosive attack, especially by agents which erode too rapidly for weathering to keep pace and to transform the resistant basalt into incoherent soil. An essential item concerning erosion of the basalt is that, despite its hardness, it is

[2] I. C. Russell: Geology and Water Resources of Nez Perce County, Idaho, *U. S. Geol. Survey Water Supply Paper 53*, 1901, p. 22.

prevailingly cut with the close-set joints of columnar structure. Incipient decay and physical parting extend down these joints far below the depths to which the cores of the columns are decayed.

The rainfall of the plateau today is inadequate to maintain a single permanent and continuous stream from its own run-off. Yet the region is strongly marked almost everywhere by running water.

FIG. 2—Eastern wall of Moses Coulee at its mouth. Minor tributaries of the preglacial valley left hanging. Cliff summit 850 feet above coulee floor. (Photograph by L. C. Robinson.)

Aside from the scablands and the more strikingly folded tracts, this stream-determined topography expresses maturity of dissection (Fig. 1). In the eastern part of the region, where the loessial mantle is from 100 to 300 feet thick, the smaller valleys are entirely in loess. The larger ones, more deeply eroded, have their lower portions in basalt and are more youthful in appearance. Their canyon-like characters are due unquestionably in part to the greater resistance of the basalt, but evidence is not lacking to suggest that much of the mature aspect of the plateau may antedate uplift.

In addition to the mature slopes of the loess mantle and the canyon-like larger valleys on and bounding the plateau, the marks of running water include the scablands. These scabland tracts are exceedingly youthful features and are distributed along almost every drainage line from the northern high edge of the plateau sufficiently important to bear a local name. Yet in large part the scablands are not valleys. Some scabland tracts are completely lacking in valleys; some include several valleys, the separating divides themselves definitely scabland; some scabland tracts which for miles follow valley courses have margining scabland above the valley walls as wide as, or even wider than, the valley itself.

With but one exception, all valleys in the scabland have some tributaries from adjacent maturely dissected loess-covered country.

Except at and near their entrance to the greatly eroded scablands, these tributaries lack all trace of either the erosional or depositional modifications that produced the scablands. Their almost unvarying accordant junction with the valleys in the scabland indicate that those severely scoured valleys existed in present dimensions before the ravaging glacial waters entered.

All of the scabland drainage ways are united in a most remarkable anastomosing pattern. The convergences in this pattern clearly were inherited from the preëxisting drainage system. But the divergences, equally numerous, are the consequence of a flooding of the preglacial valleys so great that the minor divides, even some of the major divides, of the plateau were crossed, and adjacent routes were entered. Some of the routes thus entered were carrying glacial water from the ice edge. Others did not head far enough north and, without this flooding, never could have shared in the episode. Pronounced divergences took origin more than 50 miles in a direct line from the edge of the ice. It is nothing short of amazing to find that some of these divergences required rivers 200, 300, and even 400 feet deep: not ponded conditions of that depth, but vigorously flowing rivers.

Four Major Tracts of Scabland

In terms of separate origin on the northern high part of the plateau, the youthful scabland areas are resolvable into four different portions. The greatest of these is the easternmost. It heads in the general region of Cheney, 20 miles southwest of Spokane, and enters Snake River Canyon with the drainage of the Palouse River system. It may therefore be termed the Cheney-Palouse River tract. The next spillway group to the west, the Telford-Crab Creek tract, heads in the vicinity of Telford station, about 40 miles from Cheney. The third is Grand Coulee, a single great canyon across the divide, 40 miles west of Telford. The fourth and westernmost is Moses Coulee, also a separate canyoned route but heading on the southern slope of the plateau instead of crossing the divide.

The Cheney-Palouse River tract is 75 miles long and about 20 miles wide. Not one-fifth of it is occupied by loessial islands, though it was all covered with loess before the glacial discharge occurred. Several streams enter it from loess-covered country to the east, and one stream, Cow Creek, has its entire drainage area within the scabland tract. The wide spreading of the glacial waters is strikingly shown by this extensive scabland and its seventy-odd loessial islands. Yet more striking is the existence of eight well-marked subsidiary spillways which diverged from the west side of the Cheney-Palouse River tract at distances from the ice edge ranging from 3 to 60 miles. All these required operation of the major dischargeway for their own

functioning; all were unquestionably contemporaneous at their initiation; no succession of operation could possibly have occurred by change in position of the glacial margin.

The Telford-Crab Creek scabland tract, next to the west, is as wide as the Cheney-Palouse River tract, but it loses its unity about 15 miles south of the plateau divide because of the number and capacity of divergent channels. However, convergence of all these (and of all but one of the Cheney-Palouse River divergences) occurs in a wide shallow structural sag (Quincy Basin) in the western part of the plateau. In this basin is the largest single area of gravel left by the glacial waters. It covers at least 24 townships. That all the channels of this Telford-Crab Creek spillway were in operation at one time cannot be gainsaid. There is continuous scabland northward from all channel heads of this tract across the plateau divide to the limits reached by the ice sheet. Some 40 to 50 square miles of this drain northward to the Columbia at present and did so in preglacial time; yet they clearly carried a wide, south-flowing sheet of glacial water to supply all the divergent channels.

Both Grand Coulee and Moses Coulee are canyons with maximum depths of 900 to 1000 feet (Fig. 2). The canyon character of these tracts is due to greater structural gradients of this part of the plateau. In both, there were preëxistent stream canyons (except in the northernmost 20 miles of Grand Coulee), but in both there was great deepening and widening by the glacial waters. Grand Coulee discharged a broad divergent sheet of water southeastward from its southern portion, but Moses Coulee had no divergences.

Causal Conditions Obtaining Over the Area

The anastomosing habit of scabland tracts over the entire area demands causal conditions that likewise existed over the whole region. These conditions were essentially:

1. A volume of glacial water too great for the existing valleys to carry.
2. A marked contrast in erodibility of the loess and basalt.
3. A high gradient for streams of the volume indicated by the abandoned channels.

Nowhere does the field evidence suggest any other cause, nowhere is it inconsistent with this explanation, and almost nowhere does it fail to show several mutually corroborative phenomena in support of this explanation.

More than 50 well-defined cases of divergence across loess-covered divides are known and at least three cases where such divides, parallel with (instead of transverse to) the direction of flow, were destroyed for 15 to 45 miles between the preglacial valley courses. In eight

FIG. 3

FIG. 4

FIG. 5

FIG. 3—Palouse Canyon between the two falls across the former Palouse-Snake divide. Cut about 400 feet deep. Looking north into the preglacial valley.

FIG. 4—Upper Palouse Falls. Close to the divergence from the preglacial valley.

FIG. 5—Palouse Canyon below the lower falls. Portion modified from a short preglacial tributary of Snake River. Rounded relict hill of loess on sky line.

places the divide crossings in the anastomosis were notably eroded in basalt. The most striking case is the diversion of Palouse River from its preglacial valley (Washtucna Coulee) to a very narrow canyon (Palouse Canyon) and the consequent shortening of the river by about 40 miles. Palouse Canyon (the lower ten miles of the river) is 400 to 800 feet deep in basalt (Figs. 3, 4, 5). Part of it is modified from a short preglacial tributary to the Snake, but the very narrow straight portion across the old divide clearly is a product of the Cheney-Palouse River discharge. A waterfall 196 feet high still survives in this canyon (Fig. 6).

Palouse Canyon is not the only record of the breaching of the divide. The whole summit for ten miles from east to west (transverse to the canyon) is marked scabland. It reaches 350 feet above the floor of the abandoned valley and 800 feet above the bottom of Snake River canyon to the south. Yet both valleys are preglacial. And in both

the water flowed vigorously westward and southwestward toward the Columbia.

All scabland areas descend toward Snake River or Columbia River and enter these large valleys. Here the effect of the glacial waters might presumably be indistinguishable from the work of these two rivers before and since the scabland-making episode. Such a presumption would be based on the conception of these river valleys as valleys also for the glacial streams. The river-channel characters, the key to scabland interpretation, would give place to normal valley characters. It should then follow that the extraordinary anastomosis on the plateau was the consequence of shallow streams (for their widths cannot be disputed) or that there was sequence, not synchrony, in their operation. If the great widths and great depths actually existed contemporaneously in all channelways, both the Snake and the Columbia should similarly have become channels. They should have developed some cases of divergence in consequence of the flooded condition, and their tributary valleys which did not head in the scabland should have been notably ponded by the great volume. This is a crucial test of the writer's thesis.

FIG. 6—Lower Palouse Falls, 196 feet high. (Photograph by L. C. Robinson.)

The valley system of southeastern Washington is older than any scabland. This is amply attested by the graded slopes, the development of tributary systems, the relations of loess to scabland, and the presence of old stained gravels in valley bottoms. In many places on the plateau it is clear that the scabland features are superposed on this older drainage pattern in loess and basalt. Palouse Valley, for example, was as deeply entrenched in basalt east of the scabland as it is today; and, if a dam 100 feet high were built at the head of the canyon through the divide, the abandoned route (Washtucna Coulee) would be resumed. This abandoned preglacial course, now without drainage, is more than 40 miles long and 200 to 350 feet deep in basalt (Fig. 7). Minor tributaries from a large loess-covered tract to the north join it at accordant grade, yet belong to the pre-scabland mature drainage system.

There were eight different entrances of the scabland rivers to the Snake and Columbia valleys, one of them multiple. Three of them, entering the Columbia, are over precipices 200 to 400 feet high (Fig. 8), and two of them, entering the Snake, are very narrow canyons across the preglacial Snake-Palouse divide (Fig. 9). Judged by the criteria of an accordant junction and a system of pre-scabland tributaries, the only scabland routes entering the master valleys that were inherited from the older drainage system are Moses Coulee, Crab Creek, and Palouse River (via Washtucna Coulee).

FIG. 7—Washtucna Coulee at Washtucna Lake. Scabland walls well shown. Compare this abandoned valley of the Palouse River with the canyon it now occupies. (Photograph by Robert Landon.)

Deposits in the channeled scabland system constitute another remarkable feature. There are two kinds; the channel deposits, prevailingly of pebbles, cobbles, and boulders, and the pond deposits back in valleys entering the scabland from unglaciated areas. This classification is not a rigid one, however, for in some places a ponded condition succeeded current flow.

The gravel deposits in the channels depart as much from conventional valley fills as the scablands do from valley forms. They are so situated with reference to the canyoned channels and the rock basins that they cannot be remnants of valley trains or similar deposits unless two episodes of enormous discharge be postulated. Their shapes are such that by no possibility can they be erosional in origin. They are local deposits, built beneath the surfaces of the great rivers. As channel deposits, they are contemporaneous with the erosional forms in basalt and in loess. Many of them are hills a hundred feet in height, some of them are 200, 300, and even 400 feet above their lower base. There is no term in geological literature for them except that of "bars" (Fig. 10). Their locations are all in conformity with the genesis implied by that term, as also are their structures, their shapes, and their composition. But if they are bars, the glacial streams in

which they grew far exceeded any other glacial streams in depth. Were this conception of great depth based alone on these so-called bars, it could command but little respect. Rivers of this character must have left other evidence. Some of that evidence has already been briefly reviewed. The great widths shown on the map are undeniable, the physiographically recent great scouring of the basalt over hundreds of square miles is almost startling, the scarped islands of loess still carrying the mature topography of pre-scabland time are indisputable. And such divide crossings as Palouse Canyon, formed while the pre-glacial valley a mile wide and 350 feet deep was carrying a great stream away from the threatened divide, offer strong corroborative evidence. But there is still more evidence of the flooded condition of the valleys of eastern Washington. It lies in the other type of deposit noted, the silt and sand of the ponded tracts.

A generalization to which no exceptions have yet been found is that every non-scabland valley entering the scabland contains débris carried back into it from the scabland. This débris may consist of scattered erratic boulders, cobbles, and pebbles; or of stratified silt and sand; or it may be a gravel deposit partially blocking the entrance. All three types are found in many of these valleys. The erratic character of some of the débris is not limited to the larger fragments, it is to be recognized even in the sand deposits. And some remarkable lenses of berg-laid till in the stratified sand and silt have been found.

These features are common in valleys that receive and always have received their run-off entirely from loess and basalt. In each valley the records above listed occur only up to an altitude corresponding to the upper limit of the glacial waters where that valley opens into the scabland complex (Fig. 11). The two most notable cases of ponding yet found are in Snake[3] and Walla Walla valleys. In Snake Valley, the upper limit of erratic cobbles and boulders and of stratified silt and sand is 1350 feet A. T., and the altitude reached by the glacial flood across the Palouse-Snake divide is 1325 to 1350. At the entrance of the adjacent Walla Walla Valley, 40 miles farther down the Snake, the upper limit of the glacial waters was about 1100 feet A. T., and the deposits under discussion are known up to 1080. Maximum depths of the two ponds thus recorded are about 800 feet each.

These records of ponded waters are not topographically expressed except at the very entrance of the tributary valleys into the scabland. Gravel deposits here commonly have the form of embankments which, when built, partially or even completely blocked the tributary valleys. Elsewhere the materials generally constitute a mantle on all slopes below the upper limit, thicker on lower slopes but easily overlooked if one passes through by train or automobile. In contrast, the great mounded channel deposits are almost as spectacular as the associated basalt scabland.

[3] East of the entrance of Palouse River.

FIG. 8

FIG. 9

FIG. 10

FIG. 8—Frenchman Springs Cataract. A western spillway from Quincy Basin. The total height of the irregular cliff is 400 feet.

FIG. 9—Devils Canyon. A narrow gash across a preglacial divide. No stream other than local run-off has used it since it was formed.

FIG. 10—Bar in Crab Creek Valley, south of Downs. Except at the left, a partially enclosed depression lies between the bar and the cliff.

The junction of the two master valleys, the Snake and the Columbia, in the southwestern part of the river-scarred plateau is 120 miles by direct scabland routes from the head of the Cheney-Palouse River spillway and 140 miles from the Telford-Crab Creek spillway head. All glacial waters of the anastomosis converged here and escaped thence to the Pacific along the lower Columbia. The junction occurs in a wide structural valley where there is very little scabland but a large area carrying huge gravel mounds. Nineteen townships are covered deeply with this débris. The criteria by which the mounded gravel deposits in the scabland are adjudged glacial river bars lead to the same conclusion here. The relations between these bar deposits and their basin differ somewhat from the relations in the Quincy Basin up on the plateau. These 100-foot to 400-foot gravel mounds, though clearly having constructional profiles, have steeper slopes and better-

marked river channels among them. They more nearly approximate river bars in appearance, as a scrutiny of the generalized contour lines on them (Pl. VI) will show. And they almost nowhere approach the upper limits or the outer limits of the glacial waters. In Quincy Basin, along the Telford-Crab Creek spillway group, they closely approach or actually reach both. This basin had but one outlet; the Quincy Basin had four. Scabland on the walls of this outlet (Wallula Gateway) is perfectly definite up to 1150 feet A. T. and probably extends to 1200 (Fig. 12). This gap is cut across an asymmetrical fold 12 miles south of the Snake-Columbia junction, a fold which constitutes the south wall of the structural valley. If Wallula Gateway was approximately as deep in preglacial times as at present[4] the waters flowing through it during the scabland-making episode were nearly 900 feet deep.

Obviously, another explanation is at hand

FIG. 11

FIG. 12

FIG. 13

FIG. 11—Terrace in Touchet River valley, tributary of the Walla Walla River. (Photograph by Robert Landon.)

FIG. 12—Scabland on east wall of Wallula Gateway. Smaller butte 300 feet, larger butte 450 feet above river.

FIG. 13—Near Celilo, Ore. Scarp eroded in ancient gravel formation; scabland at base a rock terrace 500 feet above the Columbia.

[4] New data seem to show this. Earlier interpretations called for considerable deepening by the glacial waters.

for the 900-foot vertical range of the marked scabland of the Gateway—that the upper scabland is older; so much older that it antedates the present depth of the canyon across the anticline. The evidence for a full development of the valley system draining the plateau before the glacial flood occurred has been outlined. The alternative hypothesis apparently cannot be harmonized with it.

FIG. 14—Steamboat Rock, in the middle of upper Grand Coulee. The largest mid-channel butte of the scabland. (Photograph by C. L. Beane.)

But before the matter be considered closed, the valley of the Columbia beyond the Gateway should be examined. Its character must have an important bearing on the problem.

CHANNELED SCABLAND BEYOND THE PLATEAU

From Wallula Gateway to the Willamette River, west of the Cascade Range and 200 miles beyond the Gateway, the Columbia basalt is the physiographically dominant formation. The plateau is generally considered to extend westward to the Cascade Range, but it is considerably more warped and folded than in eastern Washington. In a general analysis three portions may be recognized along the river: two downwarped areas separated by an area of upwarp. The river valley in the downwarps is wide and without notable walls; across the upwarp it is a canyon with maximum depth of a thousand feet. Across the folds of the Cascade Range farther west it is a great canyon or "gorge" 4000 feet in maximum depth; and still farther west, about Portland, there is a great widening which probably is largely structural.

The "wides" and "narrows" along 200 miles of Columbia River below the junction of the Snake have almost the same modifications that are found in similar situations above that junction. The wides carry great gravel deposits with bar forms almost intact. The stratification in these bars dips prevailingly away from the Columbia. The material is commonly but little worn, is poorly sorted, and is

almost all local in origin. Striking contrast exists between present Columbia River gravel and this bar material. The bars are not all spread out in the structural wides, many are built in reëntrants in the walls of the canyoned portions. Some are built high above the river, some extend almost from river level up to heights as great as 400 feet. Mouths of tributary valleys are favorite places for them;

FIG. 15—Head of Spring Coulee, a divergent canyon leading southeastward out of lower Grand Coulee. (Photograph by L. C. Robinson.)

their form, composition, and structure indicating clearly that they were built by the greatly swollen Columbia, not by the tributary streams. Not one of these deposits can be explained as old stream gravels left during the deepening of Columbia Valley, or as recording former valley trains, without doing violence to the field evidence. No other river valley in the world possesses such features, so far as the writer has been able to learn. Like those on the plateau above the junction of Snake River they are channel forms, not valley forms.

As with the depositional part of the record, so with the erosional part. There are channels, rock basins, and buttes of very youthful character, eroded in basalt, at high levels above the Columbia. They are river bottom features. They assuredly do not date back to the original cutting of the Columbia Valley. Their occurrence as actual divergences from the Columbia across divides to tributary valleys, and the building at such places in the tributary valleys of great bar dams or partial dams, demand the same extraordinary relations of volume to capacity as in the scabland system on the plateau.

The erosional features are most pronounced in the narrows. Where the contact of weaker formations on basalt was reached by the immense glacial river the overlying material was swept off to produce a broad basalt terrace, etched with the characteristic vigorous strokes and margined by a youthful scarp in the superjacent formation (Fig. 13). To build these great bars in the lower Columbia Valley, to

erode the high-level scabland and its margining scarps, and to allow the divergences into the lower courses of tributaries demand depths but little less than those at Wallula Gateway and in Snake River Canyon. A remarkable combination of all these features near the mouth of John Day River records 750 feet of flowing water in the Columbia.

The record of the great glacial river has been found as far down the Columbia as Portland, Ore. Here it appears to end in a deltaic gravel deposit which covers about 150 square miles. The surface of the deposit ranges from river level (which is nearly sea level) up to 360 feet A. T. Most of it lies above 200 feet. It is not a plane surface, and its irregularities are not due to erosion since the deposit was made. Though the structure everywhere is foreset, the direction of dip is so diverse in some places that, taken with the absence of a plane surface, it does not conform to the conception of a delta. A specific explanation for the ensemble would be difficult if one had no acquaintance with channeled scabland and its bars. But for the requirements of that explanation, the Portland Delta is ideal. It is a great assemblage of bars and channels, correctly disposed and constructed for the aggraded floor of a huge river here losing its current at the head of a broad drowned valley. The detailed relations to certain rock hills which are surrounded by the deposit are incapable of any other explanation than that of subfluvial origin of the whole deposit.

Erosional Forms in Basalt

The realization that a remarkable episode of glacial history was recorded in eastern and central Washington first came from an attempt to map and explain the bizarre erosional forms on the plateau surface. Running water, not of local origin, was clearly indicated as the map grew. Surviving areas of the earlier topography, a normal drainage pattern, were available everywhere for comparison. Certain unusual forms in the scabland and certain relationships in its pattern early led to the conception of prodigious streams. This conception demanded the existence of other features and relationships which had not yet been recognized, and it afforded a clue to the origin of some features which in themselves did not so strikingly tell of great volume. The development of the hypothesis has continually led to the finding of new field relations and new criteria, all of them consistent with the explanation, none of them pointing to any other interpretation. Furthermore, essentially every kind of evidence required by the hypothesis has now been found.

In the remainder of this paper, a genetic classification of the physiographic forms of channeled scabland will be presented.

Canyons: Grand Coulee

The empty canyons and dry cataracts of the plateau are easily the most conspicuous scabland forms. Among the canyons Grand Coulee takes precedence, followed by Moses Coulee. Grand Coulee has many times been explained as a former course of the Columbia across the plateau.[5] For a time it was considered to have been initiated by a great fissure,[6] and this idea was built into the first interpretation of the coulee as a glacially diverted Columbia.[7] Grand Coulee is nearly 50 miles long. It has an upper canyoned part about 28 miles long, a short stretch in mid-length across a structural sag (Hartline Basin), and a lower canyon about 20 miles long. At least four definite upfolds in the basalt are recognizable across the coulee, their existence conditioning the variations in character and the divergences.

Upper Grand Coulee is a simple canyon whose average depth is perhaps 900 feet. The width of its floor is nowhere less than a mile and a half and in one place is nearly five miles. In the middle of this wide place stands Steamboat Rock, a butte of basalt a square mile in summit area and 800 to 900 feet high (Fig. 14). Its summit is a part of the original plateau surface, now trenched by this glacial river canyon. Like the margining cliff summits, its top is marked by scabland buttes and channelings in basalt.

Lower Grand Coulee begins with a very irregular abandoned waterfall, 400 feet high, over nearly horizontal basalt flows. Most of the lower coulee, however, is eroded in tilted flows, along a monoclinal fold whose eastward dip is responsible for lower cliffs on that side. At least five pronounced divergent canyons lead southward and eastward out of the lower coulee and the mid-length structural basin (Fig. 15). All cross the minor upfolds of the basalt here. The head of the lowest of these is about 200 feet above the adjacent floor of Grand Coulee.

Grand Coulee is a part of the Crab Creek drainage system, but today it is a closed basin. Its lowest place, Soap Lake at the south end of the lower coulee, is shut in on the south by extensive gravel deposits. The lower coulee is made over from a preglacial drainage line out of the structural sag. Tributary furrows on the monoclinal slope to the west, expressing the general maturity of the plateau, hang hundreds of feet above the surface of the lakes on the coulee floor. The preglacial eastern wall, however, has been almost completely overrun by glacial waters and is striking scabland.

The upper coulee apparently is a glacial river canyon *de novo*.

[5] The earliest published suggestion of this appears attributable to Samuel Parker, who crossed the Grand Coulee in 1835. In his "Journal of an Exploring Tour Beyond the Rocky Mountains," Ithaca, N. Y., 1838, he speaks of the "Grand Coulé, which was undubitably the former channel of the river [Columbia]," p. 294.

[6] Probably first suggested by T. W. Symons in "The Upper Columbia River and the Great Plain of the Columbia," *47th Congr., 1st Sess., Senate Ex. Doc. No. 186*, 1882.

[7] I. C. Russell: A Geological Reconnaissance in Central Washington, *U. S. Geol. Survey Bull. 108*, 1893.

Unlike the lower coulee, its walls have no notches where preglacial drainage furrows hang above the bottom and therefore no rounded gable-like headlands in the upper profile. It is also unlike the other two scabland channel routes across the plateau divide (Cheney-Palouse River and Telford-Crab Creek) in that it is deeply entrenched. The others show scarified basalt over wide tracts, but the chief result of

FIG. 16—Part of "Dry Falls," the abandoned cataract in Grand Coulee. Summit of cliff is 400 feet above the plunge basin lake. This cataract was in use during a later episode of glacial diversion. Looking northeastward into Hartline Basin. Battleship Rock on right. (Photograph by C. L. Beane.)

glacial waters in them was to carry away the overlying loess. The upper limit of glacial water at the head of the Grand Coulee route is essentially the same as in the other two (2500 to 2550 feet A. T.), but the floor is nearly a thousand feet lower than in either of them. There are at least two reasons for this. The original spill across to the mid-coulee structural sag descended the monoclinal slope already noted. This afforded an initial descent of nearly a thousand feet in a very few miles, and the great river probably sloped back rapidly to cut the canyon. Furthermore, the coulee was in use in a later glacial episode than the one to which the rest of the scabland is ascribed. The ice of this later episode did not cross the Spokane and Columbia valleys east of the head of Grand Coulee, though to the west it advanced farther than the earlier ice sheet. Apparently Grand Coulee had already been deepened considerably in excess of the other routes and thus functioned alone across the plateau divide during this later episode. Some deepening probably occurred at this time.

The upper part of Grand Coulee, therefore, shows the following characteristic features of the canyons eroded entirely by glacial rivers on the plateau.

1. It crosses a preglacial divide. Though not an essential character, this is the prevailing relation to divides.

2. It possesses scabland on the "rim rock," above and behind the brink of the cliffs. Every canyon shows this, though not necessarily along its entire length.

3. It has steepened slopes in the loess or other sediment overlying the basalt. These are present wherever scabland occurs above the brink of the canyon walls.

FIG. 17—Head of lower Grand Coulee looking south from the brink of the old cataract. Pothole Lake at right, Battleship Rock in middle left of the view. The monocline which constitutes the west wall of the lower coulee determines the sky line. (Photograph by E. J. Evans.)

4. It has islands of loess on this upper scabland. They are found on all such scabland.

5. It has island buttes of basalt in mid-canyon.

Lower Grand Coulee lacks only the location on a preglacial divide. It shows some additional features that surely were not inherited from the preglacial drainage route.

1. Rock basins on the floor are numerous. All glacial river trenches in the scabland possess these features, except perhaps upper Grand Coulee.[8]

2. A large trans-coulee cataract exists. Most of these glacial river canyon trenches have more than one, though large cataracts also exist outside of the canyons.

3. There are several striking canyons diverging from the main canyon. These are really minor divide crossings in themselves.

Moses Coulee best illustrates one feature of these canyons, the remarkable deepening and widening locally produced in the preglacial routes. Douglas Creek, an affluent which enters the coulee 15 miles above the Columbia, may well be considered the major streamway, not the tributary, of the preglacial pattern; but its headwaters were not

[8] The floor of the upper coulee is covered with gravel and silt; and, if there are rock basins here, they are buried.

entered at the time the coulee carried a glacial river, and as a consequence the deepening and widening of the coulee left Douglas Creek Valley hanging 350 feet above the gravel fill in the coulee bottom. Wells show the fill to be more than 200 feet deep, and the amount of "hang" is correspondingly increased. Widening of Moses Coulee is responsible for perhaps a hundred feet of this total of 550 feet. Douglas Creek, though a permanent stream, has gashed the lip of the hanging valley for less than a mile back during all post-trenching time. Since the later ice sheet discharged but little water through Moses Coulee, the slow rate of normal valley deepening, compared with the rate of glacial stream canyoning, is obvious.

Cataracts and Cascades

Their name is legion. Scarcely a scabland area is without ledges transverse to its length. In some places, whole series of them are in sight from well-chosen viewpoints. Most of them have rock basins at their base, commonly empty basins. Those less than 20 feet high are almost negligible in developing the argument, so common are those of larger dimensions. Sheer descent of their full height is rare, though Palouse Canyon has one 196 feet high (now carrying Palouse River), Grand Coulee's abandoned falls (Fig. 16) are 400 feet high, and Quincy Basin has three such spillways out of the western part, with vertical transverse cliffs 200, 400, and 400 feet in maximum height. In most cases the glacial rivers descended in gigantic cascades, Moses Coulee having a complex one a mile wide and a mile long, in which the descent was 400 feet.[9]

Recession of these cataracts and cascades left canyons that may be mere niches or recesses in the basalt wall over which the water fell or that may be miles in length. Many of the smaller ones came into existence only through the sweeping off of the loess and the uncovering of buried basalt ledges of the pre-loessial topography. Staircase Rapids, near Washtucna, is an example.

Among these cataracts there were a few double falls each member of which receded at approximately the same rate, so that the island in mid-channel became very much elongated, like a great blade, as the falls receded and the canyons lengthened. Potholes Cataract, one of the three western spillways out of Quincy Basin, has the most striking mid-cataract blade. It is a mile and a half long, a quarter of a mile in maximum width at the base, and its cliffs are from 100 to 275 feet high (Fig. 18).

It seems entirely probable that upper Grand Coulee was cut through the divide by the stoping of cataracts or cascades down the steep monocline north of the structural Hartline Basin. Steamboat

[9] Not 600 feet, as previously reported by the writer.

Rock thus would be explained as a Goat Island around which both falls retreated to unite again as one and thus to isolate it. An actual case of this sort is Battleship Rock which stands just in front of the great cataract at the head of the lower coulee (Fig. 17). Another illustration of canyon-making by cascade-stoping is Devils Canyon, a short spillway from Washtucna Coulee to the Snake, 15 miles west of Palouse Canyon.

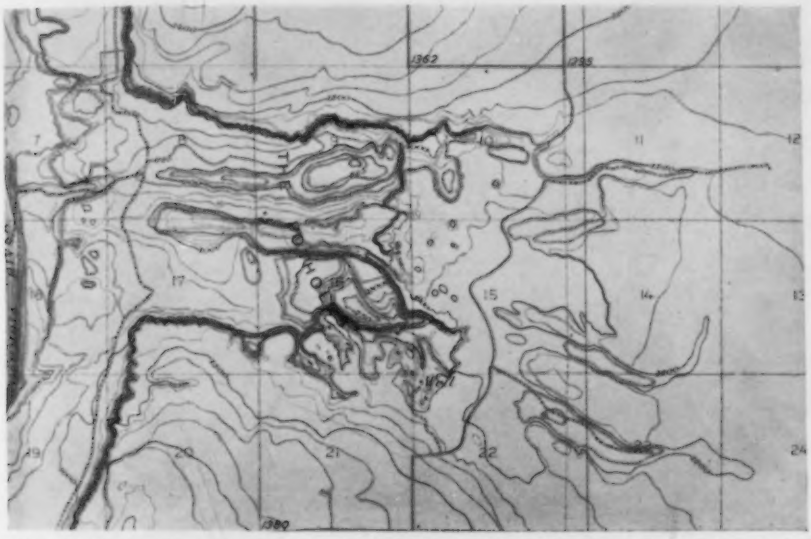


FIG. 18—Potholes Cataract, one of three cataract spillways from the west side of Quincy Basin. (From Quincy sheet, U. S. Geological Survey.)

ROCK BASINS AND MID-CHANNEL BUTTES

There is no feature of channeled scabland more challenging than the rock basins. There are thousands of them, from shallow saucers to the great canyoned basin of Rock Lake on the eastern margin of the Cheney-Palouse River spillway, more than seven miles long and having a reported depth of 250 feet near its northern end. The rock basins are not limited to the canyons and the cascade chutes or the foot of cataracts. They occur in great profusion on the broad uncanyoned heads of the two eastern scabland tracts. They occur on the torrent-swept summit of the Palouse-Snake divide, on the slopes of the preglacial valleys involved in the scabland discharge, and on the scabland benches above the rim rock of these preglacial valleys. Though not the only closed depressions left in the area after the scabland-making episode, they are the most common.

Most of the basins in the eastern and northern higher part of the plateau contain lakes and swamps today. Farther southwest, where the rainfall is less, many are empty most of the year. Some of

these empty rock basins are 200 feet deep, though they have been receiving wash ever since the glacial flood subsided. Many are so steep-walled that they can be entered only at favorable places, and the bottoms of a few are accessible only by rope or ladder. The steepness of their walls is comparable to that of the associated canyon walls

FIG. 19—Channels, rock basins, buttes, and general scabland of a part of the Drumheller Channels. Rock basins black, channels stippled, buttes and general scabland blank. The beginning and ending of many channels in the plexus is better shown here than on the contour map, Figure 21, as also is the extreme irregularity of the channel pattern. The larger rock basins are notably linear and are largely in channels. It must be understood, however, that the highest scabland is itself channel floor of the great spillway. Scale approximately 1:120,000, slightly more than half an inch to a mile.

and butte walls and has the same explanation. Both have their slopes determined by the character of the basalt. Where that has large, well-developed columnar structure (and where glacial rivers had adequate gradient) slopes are steepest: where this structure is absent or poorly developed, the rock basins have gentler slopes.

Buttes in mid-channel are far more numerous than abandoned cascades and cataracts, and most of them cannot have been formed by cataract recession. The association of isolated hills and hillocks of basalt with rock basins in the scabland channels is characteristic. Where the rock basins are deep, the buttes are prominent. Though one

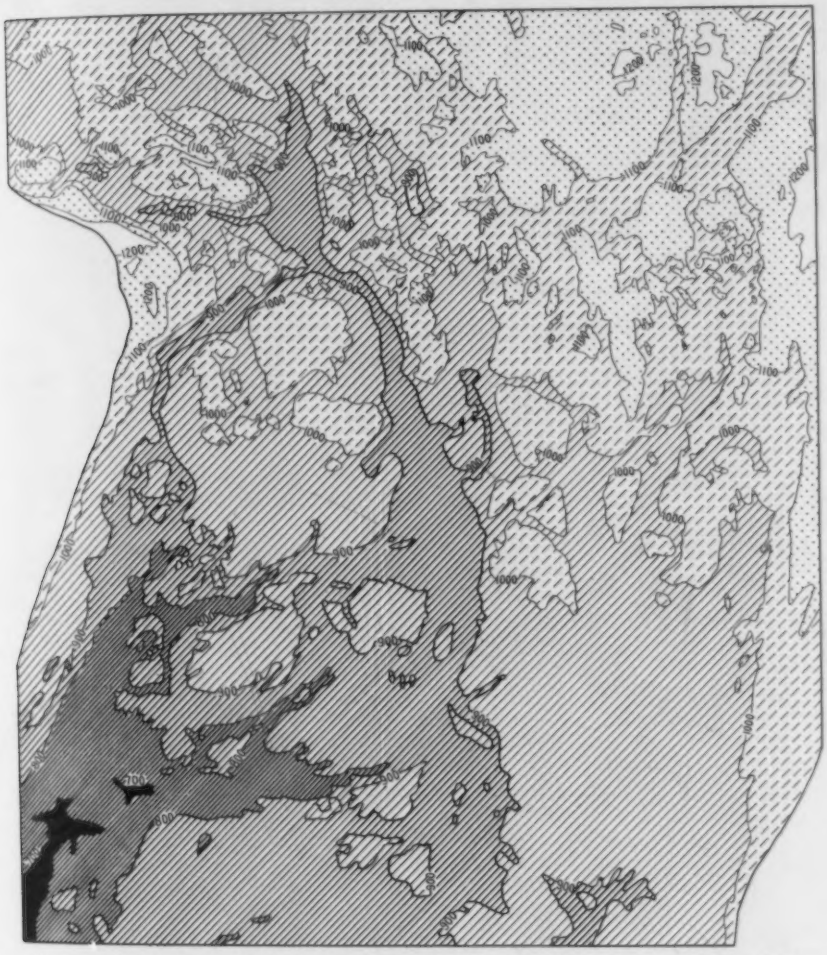
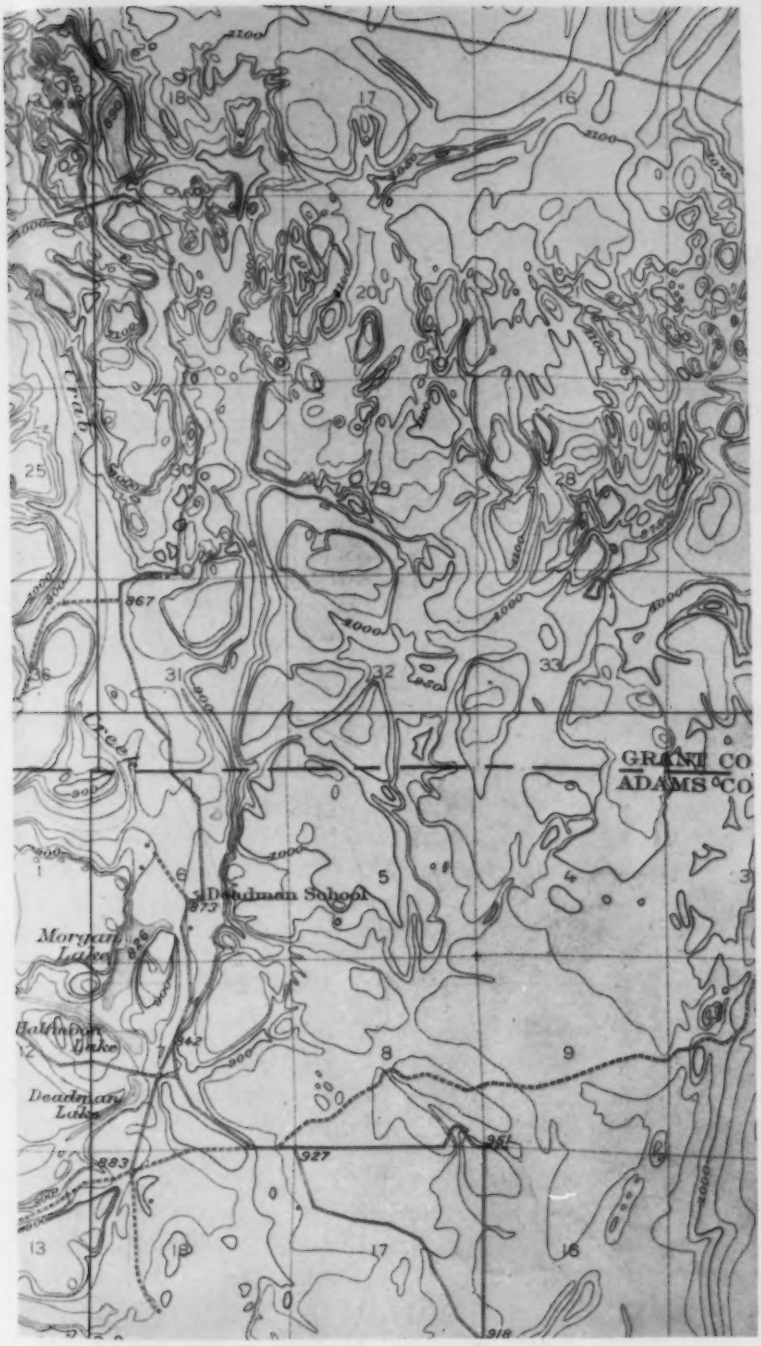


FIG. 20—Hypsometric map of a part of Drumheller Channels. Distribution of higher and lower tracts is more graphically shown than by the intricate and unusual contour pattern of the map, Figure 21. The contour interval is 100 feet. The highest areas (blank) are over 1200 feet; the lowest (solid black) less than 700 feet A.T. Comparison with Figure 19 will show the location of several of the largest (including the deepest) rock basins and many of the channels on the higher part of the scabland plexus.

is the reverse of the other, they are genetically associated forms. The conditions that gave rise to one produced the other. The maximum depth of erosion by glacial waters in any one place is the sum of butte height and basin depth. In such tracts the spacing of buttes and basins is very close.

FIG. 21—A part of the Drumheller Channels, the southern spillway from the Quincy Basin. (Reproduced from the Corfu (above) and Othello (page facing) topographic sheets of the U. S. Geological Survey.)



The area shown is slightly less than that of Figures 19 and 20 with which it is to be compared. The scale is one inch to a mile, nearly twice that of Figures 19 and 20. The contour interval is 25 feet.

Widely spaced buttes also occur on broad scabland surfaces which have no other marked relief (Fig. 22). The summits of some of these are higher than the loess-basalt contact in adjacent marginal scarps. They appear to be remnants of pre-loess elevations on the surface of the basalt and are not a record of great erosion by glacial water. But the closely associated buttes and basins have no adequate explanation other than the one proposed.

Plexus Groups: The Drumheller Channels

There are a few tracts of scabland where all the erosional features above described exist in a closely related group, in sharp contrast with the adjacent higher preglacial topography. The most marked of these is Drumheller Channels, the southern dischargeway from Quincy Basin (Figs. 19, 20, and 21). This spillway is a labyrinth of abandoned channels and rock basins among buttes, hills, and higher scabland surfaces of the basalt. The maze is eroded across the nose of a plunging anticline in the basalt. Its total width is nine miles, and in a single cross section the total vertical range of the scabland is 375 feet. It is difficult to count the channels because of the anastomosis and the indefiniteness of some of them, but nearly 150 definite channelways can be identified. They range from less than a mile to more than ten miles in length, and their floors are as much as 200 feet below adjacent butte tops. Almost every butte top has channels across it or heading on it, almost every large channel has buttes in it, and in many cases assignment of definite boundaries must be arbitrary. Most of the channels have continuous descending gradients, but there are many whose floors rise in places in what was undoubtedly the downstream direction.

Relations among these channels are instructive. The larger ones can be traced continuously through the maze, but many smaller ones and some large ones flare out downstream and lose their channel character in the generalized scabland. A larger number head in the scabland plexus 200 to 300 feet above the adjacent deeper and continuous channels. Junctions of small channels with the larger ones are but rarely accordant. The numerous small channels are on butte tops or on the higher tracts among the buttes. Their divergence from, or entrance to, the larger channels is almost invariably hanging.

Another remarkable feature of Drumheller Channels plexus is its rock basins. One hundred and eighty-two of these are shown by the 25-foot contour interval of the Corfu and Othello topographic sheets of the U. S. Geological Survey. The larger ones are in the more prominent channels and are elongated with the channel shapes. Many of the smaller ones are on butte tops, unassociated with definite channel forms.

FIG. 22

FIG. 23

FIG. 24

FIG. 22—A mid-channel butte. Absence of other basalt buttes or ledges at its level indicates that it records a hill of pre-loess topography. (Photograph by L. C. Robinson.)

FIG. 23—Trenched spur buttes in Crab Creek valley near Wilson Creek station.

FIG. 24—Scarp in loess three miles northwest of the mouth of Palouse River. Base of scarp 1320 feet A.T., about 800 feet above Palouse. A valley in the loess left hanging by erosion shows on the right. (Photograph by Donald Bell.)

Drumheller Channels constitutes one of the most peculiar groups of topographic forms to be found anywhere. It suggests karst topography, which it is not. The discontinuity and irregularity slightly resemble those of a morainic region or a tract of dunes. But the field evidence is convincing; the topography is the result of running water. For its development the tract must be covered with a current deep enough and vigorous enough to erode these channels and rock basins where there previously had been nothing remotely resembling them. It is permissible to think that, as erosion progressed, the glacial waters were concentrated in the deeper continuous channels across the ravaged anticline. But the deepest rock basin of the plexus, lying in the east-central portion, is two miles and a half from the nearest of these continuous channels, its rim 150 feet above that channel floor, and its bottom not 25 feet above. The demand for an initial great volume is obvious.

Trenched Spur Buttes and Junction Buttes

The deeper preglacial valleyways entered by the glacial streams possess a type of scabland eminence that closely resembles the mid-channel butte but has a somewhat different genesis. This type, the trenched spur butte (Fig. 23), occurs on the inside of curves of the original valley. The great glacial rivers, filling these valleys to the brim and even overrunning them, could not tolerate the leisurely preglacial curves. The submerged slip-off slopes were the most exposed places in the extemporized channelways and were most vigorously attacked. A common mode of attack was the cutting of a gorge or trench across the slip-off spur. This provided a more direct route and left a scabland butte, the terminal part of the spur, isolated in the widened watercourse. Widening by a method peculiar to this region and this episode is recorded by the buttes of this type. They are not common forms, for they require a particular setting and a particular behavior of the glacial river. They are not limited to the plateau scablands. Snake River Valley possesses two remarkable trenched spur buttes, well shown on the Wallula topographic sheet of the U. S. Geological Survey, and there is an equally remarkable situation involving trenched spur buttes in the Columbia Valley 115 miles by river below the mouth of the Snake.

In a few places where large glacial streams, occupying preëxisting valleys in basalt, joined to become one, the tip of the separating divide was severely eroded and cut into buttes much like a trenched spur series except for situation. The erosion seems to have resulted because one of the confluent rivers had superior volume and a part of it poured across the divide tip into the other valley. The junction of Crab Creek and Coal Creek, a few miles east of Odessa, possesses four such buttes in line.

Erosional Forms in Overlying Sediments

The erosional forms of channeled scabland are not limited to the basalt. Bearing their own distinctive characters, they occur in loess and other sediments that overlie the basalt. They may be classified under the terms scarps, relict hills, and channels.

By far the most common form is the scarp, a steepened slope in the overlying formation (Fig. 24). It is almost invariably parallel to a glacial river course, very seldom transverse. It invariably is marginal and almost invariably rises above the highest limit reached by glacial water at that place. It is analogous to the basalt cliffs of the scabland but always occurs at a higher level, its base essentially at the altitude of the highest rugose basalt surfaces.

Scarps commonly truncate the slopes of the mature topography. Their relations to it are like those of sea cliffs to older erosional slopes. Their heights may be as great as 200 feet, their slopes as steep as 35°. Their

Fig. 25

Fig. 26

Fig. 27

Fig. 25—Relict hill of loess, 180 feet high, surrounded by scabland. Near Hooper, Wash.

Fig. 26—Cluster of relict hills, remnants of a minor divide. Near Hooper, Wash. The hill shown in Figure 25 is one of this group.

Fig. 27—Channel in loess, looking north into Washtucna Coulee, whose preglacial floor is 350 feet lower. Nunamaker School, southwest of Washtucna, Wash.

alignment along the margins of scabland river routes, their consistent development whether the glacial river was a quarter of a mile wide or twenty miles, their formation in piedmont waste or gravel material, their orientation in various directions, their absence at the summit of loess-capped basalt cliffs in non-scabland valleys, and the occurrence of rock basins, cataract ledges, canyons, and gravel bars close to their bases—all these circumstances debar any other interpretation of them than as integral parts of the scabland system.

The "islands" of loess which make striking features on many broad scabland tracts are almost invariably elongated with the gradient of that tract and are almost invariably scarped on the sides and upgradient end (Fig. 25). Convergence of the lateral scarps to this upgradient end in many cases produces a definite prow, like the conventional pilot of a locomotive. Small "islands" may have their summits determined by the upward convergence of the lateral scarps. Larger ones commonly carry the mature topography that characterizes the loessial mantle east and south of the scabland system. Many such hills or hill groups are separated by narrow scabland channels. Some stand alone in the scabland, miles from any others of their kind. There are more than 350 of them that do not exceed five miles in length. They are commonest in elongated clusters close to the margin of a much larger tract of loess hills (Fig. 26). These clusters record one or more minor divides, the valleys among them having been completely destroyed and the divides themselves narrowed by marginal sapping until cross channels through them appeared. All gradations can be found between a group of channeled valleys in a loessial tract to a group of isolated relict hills with wide scabland separating them.

It is not difficult to see in these island hills the residuals or relicts of a once complete mantle of weaker material. The difficulty lies in explaining them by any other hypothesis. If the glacial waters diverted across the plateau had been in volume comparable to that which made the spillways from Labradorean or Keewatin ice in the northeastern and central states, only a few preglacial valleys would have been demanded to care for the discharge. The fact that two of the four source routes were stripped of their loess (except for a few relict hills) over a width of 20 miles is very significant. It is in harmony with the other phenomena of scabland, all of which call for an extraordinary volume and depth, despite the notable gradients that existed.

Glacial spillways without scabland floors exist in the anastomosis (Fig. 27). All are small features. The divides crossed by the water entering them stood too high and too far from the main routes to allow any great volume. In some of these there is good basalt scabland at the head where the divide was crossed. Most of them have definite margining scarps. Gravel deposits on their floors, typically

containing a few foreign cobbles and boulders, are also common. In large part, they are still the preglacial minor valleys, though most of them are clearly set off from adjacent valleys of this category by the features above noted.

Groups of such channels, closely spaced and nearly parallel, cross some of the relict hill areas. They are taken to represent the initial violation of the whole of the vanished loess cover. Where the broad scabland areas now exist, this initial stage was succeeded by deepening and, especially, widening until lateral planation had destroyed many thousands of these hills of the preglacial dendritic pattern.

This conception is not especially difficult to accept if no capacious preglacial valleys existed among them. Such was undoubtedly the case in the northern uncanyoned scabland tracts. But the same groupings of closely spaced channels are found farther south where there clearly were preglacial valleys 300 feet to 400 feet deep in basalt. The same flooding across minor divides to make the minor channels in loess occurred here also, despite the presence of capacious valleys below the upland loessial topography. The need for great volume is nowhere set forth more strikingly.

Depositional Forms of Channeled Scabland

It has been pointed out that all the peculiar features of channeled scabland knit together into a harmonious scheme on the thesis of tremendous volume of the escaping water. Should one, however, argue that the scabland denudation can be explained by assuming smaller streams and allowing more time, he must logically test this interpretation by the deposits of these streams. They afford probably a more crucial test of any hypothesis than do the erosional forms. As befits this paper, only the deposits with definite topographic expression will be considered.

All scabland channels possess discontinuous mounds, hillocks, or hills of stream gravel. Essentially none possess gravel terraces. The mounded deposits may occur in rock basins or perched high on channel walls. In form they are characterized by a rounded crest or summit which is commonly elongated with the channel, an enclosed or partially enclosed fosse between the crest and the adjacent channel or basin wall, and the complete absence or only the incipient stages of gullying (see Fig. 10). They are constructional forms; as definitely so as kames, eskers, cones, or deltas, though differing from all of these.

In situation they commonly lie either on the downgradient side of mid-channel buttes, trenched spur buttes, relict hills, or other eminences in the scablands; or in alcoves and recesses of the channel courses. Not a single prominent non-scabland valley entering the complex is known to be without them at the place of entrance.

In distribution they occur all through the scabland complex, from the summit of the plateau divide near the head of the channel groups to the great gravel deposit at Portland west of the Cascade Range.

In structure they are prevailingly current-bedded. Many of them possess long foreset strata like those of delta fronts, paralleling a steep slope in the mound. Their steep faces, like delta fronts, were growing faces. Débris that was swept over them came to rest in quieter places in the great rivers.

In composition these hills of gravel are dominantly of local material. Many along the Snake and Columbia have 75 to 90 per cent local material, though the present river gravels in close juxtaposition may have this ratio of local and foreign material completely reversed. Some have abundant pebbles, cobbles, and even boulders of loess, of silt, and of soft calcareous material associated with the hard basalt. Many sections show a large percentage of angular decayed basalt, well mingled with fresh "bright" fragments of the same rock. Decay of the deposits as a whole has extended but a foot or two below the surfaces. No differences have been found in amount of decay of the higher and lower deposits.

In magnitude these hills range from low mounds covering an acre or so to huge piles measuring a hundred to four hundred feet from lowest base to crest and covering a square mile or more. A few of them extend through the entire vertical range of scabland in their neighborhood. Their magnitude, both in actual size and in relation to the valleys in which they occur, is the most arresting feature among all their surprising characteristics.

They are unlike any other detrital accumulations except the much smaller features of river channels commonly called bars. With these there is exact parallelism except for size. When considered in their setting in the scabland system, with all its other evidence for great volume and great erosion, they are seen to be an integral part. They should exist! And if they are bars, the great scoured channelways should exist! Again this assemblage of unique land forms in the Pacific Northwest is seen to be a genetic group. A lively imagination is required for the acceptance of the hypothesis, but a scientific imagination withal.

The Causal Episode

It is difficult to convey by words and pictures a visualization of the observable relationships of channeled scabland. Such terms as "canyon," "cataract," "scarp," "gravel deposit," calling up images of the usual topographic forms, suggest the usual explanation, which involves far less water and far more time than the writer's hypothesis demands. Put a glacial Columbia first in one channel, then in another, then in a third, instead of running all of them at the same time; use

CHANNELED SCABLAND AND ASSOCIATED FEATURES ON THE COLUMBIA PLATEAU IN WASHINGTON

SCALE 1:500,000

MILES 0 20 40

DOUGLAS

GRANT

LINCOLN

ADAMS

Leahy

Steamboat Rock

Mansfield

Approximate Limit of Spokane Ice

Maple Creek

Dover

Brief

Mud Cr

Tonkey

Withrow

Mold

St Andrews

Farris

Entiat

WATERVILLE

Orondo

Douglas

SUNSET HIGHWAY

Farmer

Moraine

Spencer

Baird

Coulee City

Hartline

Hartline Basin

Grand Coulee

Freshwater Lake

Blue Lake

Cashmere

Monitor

Bright

Bacon

Lenore Lake

Palisades

WENATCHEE

Malaga

Soap Lake

Adrian

Stratford

Wilson Creek

Krupp

Hammond

Columbia River

Colockam Cr

Crater

Trinidad

Quincy

Winchester

EPHRATA

Gloyd

Morrison

The Potholes

Burke

Quincy Basin

Moses Lake

Neppel

Wheeler

Mae

Ruff

Weber

Schrag

Bowers

Packard

Rocky Coulee

Marcellus

Keystone

Coulee

Barrier Coulee

Pana

RITZVILLE

Big Swamp Lake

Con Lake

Plum

Clark

Miles

River Homes

Wellpinit

Hellgate

Peach

Egypt

Wilbur

Creston

Govan

Almira

Telford

Rocklyn

DAVENPORT

Wall Lake

Pacific Lake

Twin Lakes

Coffeepot Lake

Harrington

Rosalia

Mohler

Lamona

Downs

Udessa

Sylvan Lake

Sprague

Creek

Loess-covered Areas

Glaciated Areas

Channeled Scabland in Basalt, including many small gravel deposits

Channeled Sedimentary

Basalt, including many small gravel deposits

Channeled Sedimentary Rocks above the Basalt

Gravel Deposits

Silt and Sand Deposits

Lakes

Wisconsin Moraine

Margin of Spokane Ice

State Highways

700 Generalized contours in certain tracts

Definite Boundaries

Indefinite Boundaries

Walls of Grand Coulee and of north-draining canyons in Telford-Crab Creek tract

Upper Limit Data at point indicated

C = Channel head S = Silt

G = Gravel Scp = Scarp

E = Erratics Scb = Scabland

GE Scp 1630 (400)

Altitude follows abbreviation. Double arrow and figure in parenthesis indicates depth of preglacial valley below upper limit

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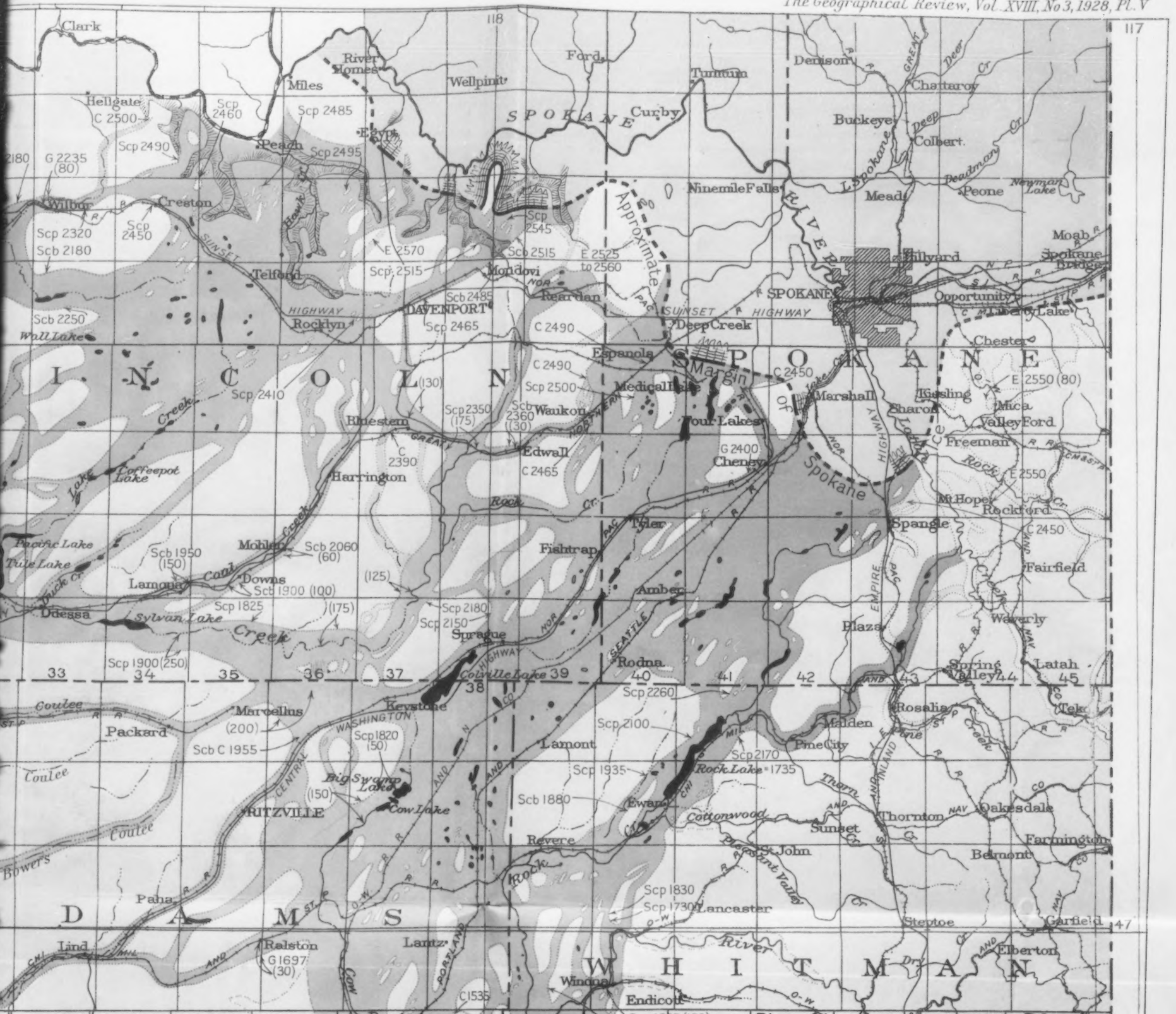
Clark
River Homes
Miles
Wellpinit
Ford
Tumtum
Denison
Chattaroy
Hellgate
Scp 2460
Scp 2485
Egypt
Curby
Buckeye
Colbert
Peach
Scp 2490
Scp 2495
Ninemile Falls
Mead
Peone
Wilbur
Creston
Scp 2320
Scb 2180
Scp 2450
Scp 2545
Approximate
Moab
Hillyard
Spokane Bridge
Telford
Scb 2515
E 2525 to 2560
Mondovi
Reardan
SPOKANE
Opportunity
Rocklyn
DAVENPORT
Scb 2485
Scp 2465
Deep Creek
Wall Lake
C 2490
Espanola
Chester
Scb 2250
Scp 2515
E 2570
Scp 2410
Scp 2500
Medical Lake
Marshall
Kesling
Mica
Valley
Ford
Waukon
Four Lakes
Rhestem
Scp 2350 (175)
Scb 2360 (130)
Edwall
C 2465
G 2400
Cheney
Freeman
Harrington
Coffeepot Lake
Rock Cr.
Mt Hope
Rockford
Spangle
Tyler
Pacific Lake
Tule Lake
Scb 1950 (150)
Mohler
Scb 2060 (60)
Fishtrap
Lamona
Downs
Scb 1900 (100)
Amber
Fairfield
Odessa
Sylvan Lake
Scp 1825
Scp 2180
Scp 2150
Sprague
Plaza
Waverly
Scp 1900 (250)
Rodna
Spring Valley
Latah
Coulee
Marcellus
Keystone
Scp 2260
Rosalia
Packard
Scb C 1955
Scp 2100
Malden
Pine City
Lamont
Scp 2170
Rock Lake 1735
Scp 1935
Big Swamp Lake
Cow Lake
Scb 1880
Ewan
Cottonwood
Thornton
Oakesdale
Sunset
Farmington
Revere
St John
Belmont
Bowers
Pana
Scp 1830
Scp 1730
Lancaster
Steptoe
Garfield
Lind
Ralston
G 1697 (30)
Lantz
Elberton
Endicott
C 1535
DAMS
WHITMAN
River
Dry
Creek
Lake
Coulee
Valley
Ford
Rock
Cr.
Creek
Fork
Deep
Cr.
Deadman
Cr.
Newman Lake
Sunset
Highway
Approximate
Margin
of
Lake
Spokane
Scb 2250
Wall Lake
Scb 2515
Scp 2515
Scp 2465
Scp 2410
Scp 2500
Scp 2350 (175)
Scb 2360 (130)
Scp 2180
Scp 2150
Scp 1900 (250)
Scp 2260
Scp 2100
Scp 2170
Scp 1935
Scp 1880
Scp 1830
Scp 1730
Scb 1950 (150)
Scb 2060 (60)
Scb 1900 (100)
Scp 1825
Scb C 1955
Scp 1820 (50)
C 2390
C 2490
C 2450
C 2465
G 2400
E 2550 (80)
E 2550
G 2235 (80)
G 1697 (30)
C 1535
(130)
(125)
(175)
(200)
(150)
(150)
(100)
(250)
(50)
2180
33
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A. Hoen & Co. Lith. Balto.

more than one glacial episode if necessary; upwarp the transected divides to give the present high altitudes above valley floors. Procedures such as described here are unheard-of. Other ice sheets have come and gone and left no such record. How could such quantities of water be yielded from so small a front and with so little retreat?

It may be that there are other significant facts yet to be discovered. But the writer is convinced that the relations outlined in this paper do exist and that no alternatives yet proposed by others or devised by himself can explain them.

That unique assemblage of remarkable physiographic forms on the Columbia Plateau in Washington, described here as the channeled scabland system or complex, records a unique episode in Pleistocene history. Special causes seem clearly indicated. But what these causes were is yet an unsolved problem.

THE PEOPLE OF THE VEIL: A REVIEW*

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University of Algiers

IN 1922 Mr. Francis Rodd undertook an extremely interesting journey to the mountains of Aïr in the central Sahara, occupied by Tuaregs, the Veiled People.[1]

Aïr is a volcanic massif, some of whose summits attain a height of 2000 meters. It lies in the heart of Africa, on the southern border of the Sahara. Our first knowledge of the region comes from Barth, who led an expedition in the service of the British government in 1850. French occupation dates from 1901, the seat of administration being established at Agades in 1904. The region now forms a *cercle* of the Colonie du Niger, the youngest of the French colonies. The colony is administratively attached to French West Africa, whose capital, Dakar, is 3000 kilometers distant in a direct line, without any modern means of communication.

Aspects of Aïr

The country is pacified but still is imperfectly known. In addition to the accounts of the earlier explorers, Barth and Foureau and Lamy, we have the very incomplete maps of Cortier, "Les Touareg du Sud-Est L'Aïr" by Lieutenant Jean (1909), the first French officer in charge, a chapter in Chudeau's "Sahara Soudanais" (1909), Buchanan's "Out of the World North of Nigeria" (1921), and finally Abbadie's "La Colonie du Niger" (1927), published after Mr. Rodd's book had appeared. These constitute almost the entire bibliography.

Aïr is separated from the English frontier by some 300 kilometers of steppe. Mr. Rodd crossed it by the old road through Tagedufat; almost abandoned today, says Colonel Abbadie, for the western road, where the wells are better. He traveled lengthwise of the massif, which is 200 kilometers long and 60 kilometers broad, from Agades to Iferuan. His route is tied up to astronomically determined points, including his own observations. He rediscovered Barth's old camp, Tintellust, which does not appear on the French

* Francis Rennell Rodd: People of the Veil. Being an Account of the Habits, Organisation and History of the Wandering Tuareg Tribes which inhabit the Mountains of Air or Asben in the Central Sahara. Macmillan & Co., Ltd., London, 1926.

[1] The journey was made in the company of Angus Buchanan, who had previously visited the area, and T. A. Glover.

Mr. Rodd has lately returned from another journey to Aïr, the results of which are briefly announced in the London *Times* for March 19 and 20.—Edit. Note.

maps. He makes some interesting suggestions on the wadis of southern and southeastern Aïr. What is least known in Aïr is the network of valleys. Extensive massifs, such as the Bagezan Mountains, remain unexplored. Mr. Rodd explains why. They are practically inaccessible to the camel, the only beast of burden, and porters are not to be enlisted. He describes the Damergu country in exact and vivid terms, noting the pleasure of the traveler who suddenly emerges from the suffocating discomfort of the thorny bush to enter its cultivated fields. Mr. Rodd unfortunately is no physiographer: to find an explanation we must look to Chudeau who points out that the bush flourishes on sandstone (Lower Cretaceous), while the surface of Damergu is covered with clay (Middle Cretaceous), which retains the waters of the rare storms. Other land forms of special interest noted by Mr. Rodd are the Tiggedi cliff, 200 kilometers long, apparently a fault scarp of a type known elsewhere in the Sahara and well preserved under the arid climate; and Mt. Gheshwa, a cinder cone with fresh lava flows. It has long been known that Aïr is volcanic, but so recent a volcano has not, I believe, been pointed out before.

However, it is not so much the country that interests Mr. Rodd as its inhabitants, as the title of his book implies.

The Inhabitants: Tuaregs

Climatically Aïr belongs rather to the Sudan than the Sahara, since it has a season of regular, if scanty rains. As a result the basis of the population is black, Hausa; but the neighboring Sahara has furnished the white aristocracy, the Tuaregs. The massif has two names: Aïr, which is Tuareg; Asben, which is Hausa. It is the Tuareg who interest Mr. Rodd, these "People of the Veil," so named from the most striking feature of their appearance. Mr. Rodd lived the Tuareg life, seeking to make its intimate acquaintance. "They were my very good friends," he says in his conclusion, "and I was very pleased to live with them, for they were very agreeable." This spirit of friendship indeed permeates the book and makes for its attractiveness. Mr. Rodd communicates a sympathetic feeling for the Tuareg to the reader and inspires the like for himself.

To see deeply into a human society one must approach it thus *con amore*. In addition Mr. Rodd brings a spirit of exactitude, even of meticulousness. He does not deform a fact, and he has good sense. On the Tuaregs—their society, political organization, mode of life, implements—he has gathered very complete data, which he presents in a well balanced picture. I do not know where one would find its equivalent, even in French; certainly not in English.

Mr. Rodd has contributed little in the way of new facts, but he makes some interesting suggestions for further research. He notes in

passing, "the wild men of Aïr," who live in the Tamgak Mountains. They are "nobles," whites that is, who "speak a language which the Tuareg do not understand." Unfortunately he has to add "I never succeeded in seeing these curious people." Mr. Rodd also mentions the libraries of Aïr. "Most of these precious books . . . were lost when the whole of Aïr north of the Central massifs was cleared by French Camel patrols after the 1917 rebellion." It is one of the many unhappy consequences of the war. Arab books 99 times out of a 100 are a deception for historic research; but assuredly all that can be saved should be saved. There is tempting work for an arabist.

The Problem of Tuareg Origins

Where he is dealing with facts Mr. Rodd is sure; but the Tuareg problem is too intriguing for him not to essay its solution. He builds theories and here is less happy. Furthermore, though Mr. Rodd speaks Arabic and his career in the diplomatic service put him in touch with the Near East he unfortunately does not appear to be acquainted with the Maghreb (French North Africa).

Aïr is a little corner of the Tuareg world which encompasses all the central Sahara. Mr. Rodd sets out from his corner by extensive reading. He plunges bravely into the bibliography of the subject, but it bristles with difficulties. It is very scant and in process of rapid revision. To judge by his silence some important facts seem to have escaped Mr. Rodd. For instance, he does not appear to be aware of the tomb of Tin Hinan,[2] which is dated and which throws a most significant light on the Tuaregs of the Middle Ages. Nor does he appear to be acquainted with the monuments, the so-called "sacrificial circles," which have often been photographed and which certainly are related to a pre-Islamic Saharan religion.

He notes in Aïr, "Early Period" rock drawings, which would be an interesting novelty. But he tells us they are "accompanied by . . . inscriptions" and that they "represent animals which exist," . . . "there was no chiselling or cutting: the lines were made by hammering" . . . "they portray a similar fauna and habit of life to those of today" (pp. 264–265). All these features are contrary to what one knows of "early rock drawings," which represent a fauna vanished, as the elephant, or extinct, as *Buffelus antiquus;* when human figuration appears it has no relation to the present-day peoples; the drawing is never "hammered"; it is always deeply "cut."

The veil is not as exclusively a Tuareg characteristic as Mr. Rodd believes. The Tibbus of Tibesti, who are an entirely different Saharan group, also use it (see Nachtigal). The Tuaregs of Aïr, like those of

[2] E. F. Gautier: The Ahaggar: Heart of the Sahara, *Geogr. Rev.*, Vol. 16, 1926, pp. 378–394.

the Ahaggar, are so exclusively meharists that "dissociation of the Tuareg from his camel is difficult to conceive." And yet there are around Timbuktu, in the bend of the Niger, a group of Tuareg who are strangers to the camel. They are horsemen, pure and simple, a fact which involves a modification of their manner of fighting. They carry two javelins which they can throw from horseback at a gallop with astonishing dexterity. Aside from this the group seems to be similar to the others, at least as far as one knows; for, despite the fact that they are probably more important numerically, they are less well known.

The works studied by Mr. Rodd appear sometimes to have given him difficulties of interpretation. Halévy was in his time an erudite scholar. He sought to explain the Libyan alphabet by the Phoenician, ancestor of the T'ifinagh characters retained in Tuareg usage. But Halévy wrote a half-century ago. Since then the excavations of Evans in Crete have revealed to us a sea aristocracy of the Aegean, preceding that of the Phoenicians; and the clay tablets unearthed by him at Cnossos bear characters whose resemblance to the Libyan and T'ifinagh characters is troublesome. Seeking the etymology of the word "Tuareg," which is the plural form of "Targui," Barth proposed an Arab root which signifies "renegades," and Duveyrier fell in with the suggestion. The Tuaregs assuredly are lukewarm Mohammedans, and the Arabs may justly reproach them in this respect. Barth and Duveyrier are great names in Saharan exploration; but they wrote three-quarters of a century ago. The etymological puns to which the Arabs are prone are today discredited. Furthermore, since the time of Barth and Duveyrier the Arab historian Ibn Khaldun has come into prominence; he reveals to us the existence in the Middle Ages of a Veiled tribe, which he calls Targa, plural Tuareg. The name of this tribe has doubtless been extended to all wearers of the veil. Mr. Rodd appreciates the importance of this great historian. He devotes a long analysis to his work in which, however, I believe he has lost the thread. As he himself observes, "Ibn Kaldun's writings are voluminous and have a baffling tendency to jump about from subject to subject."

Mr. Rodd objects to the use of the name Berber, "which implies a number of wholly imaginary anthropological connections. Moreover it is even open to doubt whether the Tuareg are Berbers at all." He says that the language of the Tuaregs is "one of the languages termed 'Berber,' the only connection in which I am prepared to admit the use of this word." But no one careful of scientific expression employs it in other sense than that accepted by Mr. Rodd himself. "Berber" is applied to a group of tribes pertaining to the white race whose sole bond is community of language; no other definition is possible. And the Tuaregs assuredly belong to this group spread over all North Africa west of Egypt.

The ancients named North Africa Libya and its inhabitants Libyans. The Latinized cities of Roman Africa, in current usage applied the term "barbari," barbarians, to all the natives who had not adopted the Latin tongue. The Arabs arabicized the Latin name. This etymology is not accepted by all scholars, but it is evident enough to those who day by day see French words passing into Arabic or into Berber. The French "bidon" becomes "beidoun," plural "bouadin"; "jugement" becomes "jugmen," plural "djouadjem"; "automobile" becomes "tomobil," plural "timmaboula." It is probable enough that "barbari" became "berberi," plural "Beraber," whence our "Berbers." One thing is certain. After the Arab invasion the word "Libyans" was immediately displaced by "Berbers," which has exactly the same significance.

But too much stress has been laid on these erudite controversies. Mr. Rodd, as we have said, is an admirable observer of concrete facts, and his fundamental good sense reappears in his conclusion to which all can subscribe, if formulated in somewhat different terms.

The Tuaregs are a group of Berber tribes, or, if Mr. Rodd prefers, Berber-speaking peoples. But the group is fundamentally different from the others. Everything—physical build, psychology, social organization, material equipment—puts them in a class apart. They have had a great past, much more brilliant than their present, as Mr. Rodd has sensed. Precisely what their past has been I am not prepared to say. I believe that Mr. Rodd has anticipated certain researches that remain to be undertaken and discoveries that remain to be made.

The Sahara in Ancient Times

A book by André Berthelot, "L'Afrique Saharienne et Soudanaise: Ce qu'en ont connu les Anciens," just published,[3] is full of interesting suggestions regarding the great problem which has inspired Mr. Rodd. To understand the past history of the Sahara one must go back to the Glacial period. At this time when Europe was mainly covered by ice the great human habitat was in the Sahara, not then a desert, but a steppe traversed by great rivers. And not only the Sahara properly so defined, but also Arabia, the Syrian Desert, and Mesopotamia. All this desert terrain of today may well have played the rôle of refuge, as the botanists say, at the time when Europe to the north was ice-covered. This has a bearing on the detailed facts that have not escaped Mr. Rodd.

In the Sahara is found a magnificent collection of Neolithic tools, perhaps the best in the world. It includes great numbers of enormous primitive millstones for grinding grain. Now the cultivation and utilization of the food grains in the Sahara still exhibits an astonishing-

[3] Les Arts et le Livre, Paris, 1927.

ly primitive character. Certain grains, for example *Aristida pungens*—the drinn of the Arabs, toulloul of the Tuaregs—are gathered and made into flour as soon as nature furnishes a supply: they are not cultivated at all. Such a proceeding savors of the dawn of cereal agriculture. It is not impossible to conceive of agriculture being born here.

Then came the great catastrophe, desiccation, the more or less slowly progressive invasion of a desertic climate. Agriculture and civilization quickened their evolution in the valleys of the only great rivers surviving—Nile, Tigris, and Euphrates. On the rest of the terrain, henceforth desert, agriculture remained in a state of arrested development, fossilized one might say. Many of the characteristics of Tuareg civilization go back to this period, properly antediluvian.

Much nearer our own time we can clearly see in the history of the Sahara certain great turning points. Probably no one has emphasized so strongly as Berthelot the profound and terrible repercussions of the appearance of firearms in the Sahara and Sudan. Evidently this revolution contributed to the decline and retreat of the Tuaregs. As Mr. Rodd notes, it is a point of honor with them to remain faithful to exclusive use of side arms: a virtue of a necessity, for how could these poor folk buy rifles? But it is in the Sudan especially that the consequences of this revolution have been frightful. Up to the sixteenth century the great negro empires of Ghana, Melle, and Songhai existed on the border of the Sahara and Sudan. They represented a beginning of public order and under them agriculture had flourished, as Mr. Rodd has observed. Their prosperity was abruptly broken towards the middle of the sixteenth century when a Moroccan army took Timbuktu and overturned the Songhai Empire. This little army, which included many Spanish mercenaries, owed its success to firearms—the first seen in the Sudan. From that moment the Sudan entered on a period of ravishment and untold suffering which European colonization has scarcely ended yet and whose consequences are far from being effaced. This was the period of slave trade on a grand scale for foreign markets.

Another great revolutionary event in the history of the Sahara, of earlier date but still within the clear light of history, was the arrival of the camel. It is definitely known that the camel was introduced by the Romans at the end of the Empire, between the time of Septimus Severus and that of Hadrian. It is impossible to imagine the Sahara today without the camel; and yet such must have been the case.

At an epoch still more remote the horse was introduced. The horse unquestionably came from Asia: it appeared in Egypt towards the epoch of the new empire, two millenniums before Christ. Note that the horse as well as the camel is a military beast. The first tribes who had horses had a superior force which they did not hesitate to abuse.

The Sahara as a Human Region

In our customary view of things we see the Sahara solely as a barrier between two different zones. Looked at in the true historical light it is a region itself, with its own history and a history furthermore closely related to our European civilization.

Of this history and its crises the Tuaregs are only a curious survival. They cannot be understood without a comprehension of the human past in the Sahara. Today as the automobile makes this mysterious region accessible one may hope to lift the veil.

One of the most interesting aspects of Mr. Rodd's book is that it is the work of an Englishman treating of a French colony. It sets an excellent example. English or French, the Sudan is the same country. Nigeria and French West Africa have many interests in common. Mr. Rodd believes that the dearly-won victory of some French officers about Agades in 1917 "saved a British colony from facing a situation which might have become serious." This little feat of arms, he says, has "probably never even been heard of, still less recognised, in England."

Mr. Rodd notes the important rôle played by the Tuareg in the caravan trade of Nigeria. On the Niger bend, the old and dead town of Gao, former capital of the Songhai Empire, is taking life again and becoming the center of an important trade in French cattle sold in English Nigeria. In the heart of the Niger bend, the Mossi country is the center of a temporary migration of agricultural laborers who cross the frontier to amass a small peculium in pounds sterling. The government of French West Africa, after a long inquiry into the cotton plant, recommends a species acclimated in Nigeria. The great towns of northern Nigeria—Sokoto, Katsena, Kano—are important as the points whence set out the trans-Saharan routes of Aïr.

And yet these two complementary regions are quite ignorant the one of the other. The political frontier, an artificial matter of treaties, seems to oppose an uncrossable barrier to mutual investigation. I know of but one scientific expedition that has worked impartially in the English as well as the French Sudan, that of the German, Leo Frobenius, who has published his results in the books "Auf dem Wege nach Atlantis" (1911) and "Und Afrika sprach" (1912); and it appears that he found difficulties at times. In the second work he complains of certain English officials, and, unless I am mistaken, these officials on their part have no altogether happy recollection of Frobenius. Mr. Rodd's journey shows that the obstacles are not insurmountable. It is true that he was able to renew a war-time camaraderie with the French officers commanding the military posts, and this naturally contributed to his success. But his personality, which shines through his book, would alone have assured it.

THE ALTITUDE OF ACONCAGUA

Luis Riso Patrón

Chief, Chilean Section, Tacna-Arica Boundary Commission

ARTICLES still appear in print now and then calling attention to what is considered to be the lack of accuracy in the determination thirty years ago of the height of Mt. Aconcagua, the King of the Andes.

It was for this reason that I was persuaded in 1910 to write to M. Victor Huot of the staff of *La Géographie*. In my letter, from which an extract was published in *La Géographie* of August 15, 1910, I explained the method by which we determined the height of 6960 meters as adopted on the Aconcagua sheet of the series of maps of the Chile-Argentine Boundary surveyed by the Chilean Boundary Commission and published by the Oficina de Límites of Chile. The method had already been explained in my book "La Cordillera de los Andes entre 30° 40′ i 35° S. (1903)." In 1925 a question concerning the "exact" height of Aconcagua was addressed to me from Washington, the information not having been found in my "Diccionario Jeográfico de Chile" (Santiago, 1924) because Aconcagua is on the Argentine side of the Cordillera. Dr. Robert Helbling, in his "Beiträge zur topographischen Erschliessung der Cordilleras de los Andes zwischen Aconcagua und Tupungato" (Zurich, 1919), stated that the geographical position of Aconcagua was still uncertain and that it was still doubtful whether it was the highest peak in the Americas. In referring to the work of the Chilean Boundary Commission, Dr. Helbling stated that our methods of survey were directed by the Argentine Commission. I wish to say that the methods and procedure of the two commissions were completely independent of each other.

In order to establish the accuracy of the determination of the altitude of Aconcagua by the Chilean Boundary Commission and to substantiate my assertion that Aconcagua is the true King of the Andes, it may be of interest to summarize the methods by which the determination was made.

Methods of Determination

In "La Cordillera de los Andes entre 30° 40′ i 35° S." it is clearly explained that we took as initial control for our Andean trigonometrical operations the positions of well fixed points at Illapel (lat. 31° 38′ S., long. 71° 11′ 3″ W.), San Felipe (lat. 32° 44′ 56″ S., long. 70°

43′ 42″ W.), and Santiago (lat. 33° 26′ 42″ S., long. 70° 41′ 34.5″ W.). By a system of precise traverses we entered the Cordillera, developed our traverse network therein, and finally closed on the starting points with the precision at which we had aimed. I have shown in my book that the errors of closure were satisfactorily small. The map on which have been plotted the trigonometrical operations (scale 1:250,000) between latitude 32° and 35° S. also shows that

FIG. 1—Cerro Aconcagua and vicinity (scale 1:600,000) from the Santiago-Mendoza sheet of the American Geographical Society's Millionth Map of Hispanic America. This section of the Society's map is compiled from the Aconcagua sheet of the boundary surveys published by the Comisión Chilena de Límites and the surveys for the Transandine Railway.

the intersection of Aconcagua was very good and that no large errors in regard to its position are to be feared. We also have demonstrated that in connection with the heights our trigonometrical work was sufficiently precise.[1]

We obtained our datum level from the railroad in Illapel. We then proceeded up into the mountains and eventually returned to the San Felipe pillar (lat. 32° 49′ 53″ S., long. 70° 36′ 5″ W.). The traverse stations were on the average about four kilometers apart, and when this part of the traverse was adjusted the correction for

[1] A technical description of the surveying operations of the Chilean Boundary Commission is to be found in Volume 16 of the *Geographical Journal* (1900), pp. 329–345. The author of the paper, Professor A. Bertrand, devised for use on these surveys a precise and ingenious procedure for determining the distances between the traverse stations.

height per station was only 0.03 meter. From San Felipe we entered the Andes again, proceeded southwards, and terminated our traverse at the top of the little hill Santa Lucia in the center of the city of Santiago. On this latter half of the traverse the height correction per station was 0.26 meter.

Aconcagua belongs to the Illapel-San Felipe network; and, as the former was intersected before eight traverse stations had been occupied, it seems probable that the altitudes of the stations used in determining the height of the mountain peak are at most only a few meters in error. In addition our traverse control connected with the Punta de Vacas railroad station in the Argentine Republic, and there our trigonometrical leveling was again verified.

The height of the instrument was never taken into account, as we only found it necessary to observe vertical angles to the nearest minute (at a distance of 35.25 kilometers one minute subtends 10.2 meters).

Other Determinations

A good many attempts have been made to fix the height of Aconcagua. Pissis calculated it as 6797 meters in 1852 and as 6835 meters in 1858 and 1875 from a large triangulation not well checked. Güssfeldt,[2] starting from a base whose height (4098.6 meters) had been determined by means of a single mercurial barometer, computed three altitudes corresponding to the three principal peaks of the summit:

Highest point on the northeast side	6970 meters
Center	6851 meters
Southeast peak	6894 meters

Fitzgerald,[3] in 1897, determined the altitude as 7073 meters, and the Argentine Boundary Commission, in 1898, determined it to be 7130 meters. I have found that Fitzgerald's determinations and those of the Argentine Boundary Commission are all too high in this section of the Cordillera. Moreover, as Dr. Helbling remarks in the book quoted above, neither has given any details as to how their altitudes were determined.

Schrader,[4] in 1904, made a very careful determination of the altitude of the mountain. While carrying out the surveys for the Transandine Railway under commission from the Argentine government, he was able to make several observations from two points whose altitude had been determined with respect to the altitude of the railway station at Las Cuevas (3151.3 meters). He computed the altitude at 6953 meters.

[2] Paul Güssfeldt: Reise in den Andes, Berlin, 1888.
[3] E. A. Fitzgerald: The Highest Andes, London, 1899.
[4] *Comptes Rendus de l'Acad. des Sci. [de Paris]*, 1907.

If we reject the results obtained by Fitzgerald and by the Argentine Boundary Commission, it will be seen that the determinations made by Güssfeldt, Schrader, and myself are in very close agreement.

Güssfeldt	6970 meters (22,867 feet)
Schrader	6953 meters (22,811 feet)
Riso Patrón	6960 meters (22,834 feet)

I believe it to be well established, therefore, that the height of the mountain is between 6950 and 7000 meters (22,800 and 22,900 feet), which is sufficient to fix it as the highest mountain in the western hemisphere. It is followed in order of magnitude by:

	Approximate Latitude	Height
Ojos del Salado	27° 7′ S.	6870 meters
Huascaran	9° 4′ S.	6763 "
Tocorpuri	22° 26′ S.	6755 "
Llullaillaco	24° 43′ S.	6750 "
Mercedario	31° 59′ S.	6670 "
Tres Cruces	27° 4′ S.	6620 "
Sorata (Illampu)	15° 50′ S.	6550 "
Tupungato	33° 22′ S.	6550 "

Mt. McKinley, considered to be the highest peak in North America, with an altitude of about 6182 meters falls far short of these peaks.

It is of interest to note that the Swiss guide Zurbriggen of the Fitzgerald expedition was the first man to climb to the top of the mountain. He made his ascent on January 11, 1897, and was followed on February 13 of the same year by Vines and Lanti of the same expedition. Sir Martin Conway[5] and his guide Maquignaz failed in an attempted ascent in the following year. Messrs. Ryan, Macdonald, and Cochrane, accompanied by the muleteer Carlos Lobas, climbed to the summit in 1925.[6] Perhaps the most audacious effort to climb the mountain was that made in the summer of 1926 by Mr. Cornelius Van Engert, Chargé d'Affaires of the United States Embassy at Santiago. He left his mules and guides at an elevation of about 6000 meters, and in the two days following climbed alone in the direction of the highest peak. He had the misfortune to mistake the way on the first day and on the second was forced by a snowstorm to abandon the attempt at about 500 meters below the peak.

[5] Martin Conway: Aconcagua and Tierra del Fuego, London, 1902.
[6] Ascent of Aconcagua, *Geogr. Journ.*, Vol. 66, 1925, pp. 44–46.

CAPTAIN WILKINS' ARCTIC EXPEDITIONS, 1926–1928

A SUMMARY STATEMENT*

Svalbard Radio April 21

Amer. Geogr. Soc. of N. Y.
Broadway and 156 St., N. Y.

Traversed course outlined. One stop account bad weather. Arrived twenty and half hours flying time. Five days Barrow. No foxes seen. Wilkins.

THUS summarily Captain Wilkins informed the American Geographical Society, the scientific sponsor of his arctic expeditions of 1926–1928, of their successful culmination.

The course traversed from Barrow to Spitsbergen, the first to be made over the Arctic Basin from Alaska, was that planned as being most likely to lead to discovery of land. "No foxes seen" means "no land found," in the language of the code previously agreed on to permit the Society to make the first announcement regarding this feature of the expedition.

The flight was a justification of Wilkins' faith in the airplane as an instrument for polar exploration. "Long-distance flying in the Arctic is not more hazardous than long-distance flying in other regions," he says as a preface to "Polar Exploration by Airplane," his contribution to the Society's publication "Problems of Polar Research."[1] Wilkins' faith, however, was based on long experience. This paper to which we have referred, eminently practical as it is, inspires confidence. Captain Wilkins has had experience both in aviation and in polar exploration. As second in command of Stefansson's party on the Canadian Arctic Expedition of 1913–1918 he made intimate acquaintance with the nature of Arctic ice, an acquaintanceship that on the recent expeditions has stood him in excellent stead. He was second in command of the British Imperial Antarctic Expedition, 1920–1921, and naturalist on Shackleton's last expedition, 1921–1922. The Antarctic experiences confirmed in him the desire to prosecute in particular one phase of polar exploration, the reconnaissance study of meteorological conditions with a view to practical applications, notably in relation to the forecasting of Australian

*Captain Wilkins' own account will appear in the October number of the *Geographical Review*.

[1] Problems of Polar Research: A Series of Papers by Thirty-One Authors, *Amer. Geogr. Soc. Special Publ. No. 7*, 1928.

weather. As he says in the introduction to his report of the Detroit-Arctic Expedition of 1926: "The science of meteorological forecast has been through the ages one of the most absorbing occupations of humanity, and its possibilities, the prevention of suffering from unexpected droughts and subsequent famine, are humane in the extreme, and its economic advantage, enormous. . . . It has long been my desire to foster the development of polar meteorology by making it possible to carry out a series of prolonged investigations in polar regions."[2] The Arctic expedition of 1926 was planned "as a preliminary to a longer expedition to the Antarctic in the region between King Edward VII Land and Graham Land," as announced by the Society in 1926.[3]

In addition to the meteorological data and the knowledge to be gained of aviation under polar conditions the Arctic expeditions had another objective of their own—exploration of the unknown areas, which at the beginning of 1926 covered some million square miles. The main achievement of the 1926 expedition was, however, accomplished on the Alaskan mainland.

The Expedition of 1926[4]

Barrow was selected as headquarters because of its relation to the unknown areas. Plans had been formulated too late to permit supplies to be taken in by boat the preceding summer. It was necessary to convey them overland. An experiment in the use of snow motors proved unsuccessful under the condition of deep, soft, powdery snow obtaining in the Alaskan interior. A dog team took 63 days to reach Barrow from Fairbanks with much loss and hardship. On the other hand the airplane proved highly successful; altogether over 6000 miles of flying were done within the polar circle, most of it over unknown territory. With deviations on account of weather a compass route was flown from Fairbanks to Barrow across the divide between the Arctic and Pacific Oceans—the Brooks Range—named in honor of the late Dr. A. H. Brooks.[5] In the Endicott Mountains section Wilkins describes peaks as attaining 10,000 feet.[6] "It was quite difficult from observations to be sure which valleys were which and because snow patches often resemble lakes and many lakes were hidden in the land with a common blanket of snow.

[2] Manuscript report in the files of the American Geographical Society.

[3] Captain Wilkins' Arctic Expedition, *Geogr. Rev.*, Vol. 16, 1926, p. 149.

[4] This expedition was known as the "Detroit Arctic Expedition" from the financial support given by citizens of Detroit, especially by the Detroit Aviation Club.

[5] See Philip S. Smith: Explorations in Northwestern Alaska, *Geogr. Rev.*, Vol. 15, 1925, pp. 237–254. Dr. Smith's party crossed the range farther to the west. He describes it as "at least 150 miles wide; its higher peaks rise to elevations of 8000 feet or more, and its crest averages 5000 to 6000 feet above the sea."

[6] Striking photographs of the Brooks Range taken by Captain Wilkins appear in "The Geography of the Polar Regions," *Amer. Geogr. Soc. Special Publ. No. 8*, 1928, p. 193.

There were many more lakes and rivers than marked on the chart, and this made map reading very difficult and confusing. However, we were flying the compass course and gradually gained height until 10,000 feet was registered on the altimeter. Even then we seemed just above the highest peaks which according to our maps were only 5000 feet high."

Four return trips were made across the ranges from Fairbanks to Barrow and back, and on one of the outward journeys flight was continued 100 miles within the unknown area of the Arctic Sea north of Barrow. The flights made by Captain Wilkins with Lieutenant Eielson as pilot well merit the encomium of Byrd and Stefansson as "one of the most heroic and dramatic adventures of polar history."[7]

The Expedition of 1927[8]

The voyage of the *Norge* had rendered doubtful the existence of land along the meridian from Point Barrow to the pole. Captain Wilkins' plans for 1927 therefore called for exploration in the unknown segments northwest and northeast of Barrow. When all was ready for the take-off weather conditions favored an attempt to the northwest into the tract between the route of the *Norge* and the drift of the *Jeannette*, into which it was planned to fly to latitude 78°, longitude 180°. The results have been briefly described in the *Geographical Review*.[9] Wilkins flew 450 miles before being forced down at a position estimated at latitude 77° 45′ N., longitude 175° W. Bad weather was encountered on the return, and the plane ran short of gasoline about latitude 72° 15′ N., longitude 160° W. Wilkins and Eielson first drifted on the ice and then walked over the ice to shore. Two perfect landings on the sea ice proved Wilkins' contention that such a procedure was possible.

The chief accomplishment of the flight was the determination of the ocean depth at the farthest point reached. The preliminary figure was given as 5625 meters. A more refined calculation is now available. In view of the importance of the sounding, the deepest so far recorded in the Arctic, it may be well to describe briefly the method of calculation. Two determinations by the sonic depth finder gave time intervals between detonation and echo of 7.3 and 7.25 seconds respectively. The rate at which sound travels in sea water varies with variations in temperature, salinity, and depth. A recent publication by the U. S. Coast and Geodetic Survey[10] includes a table

[7] R. E. Byrd and Vilhjalmur Stefansson: The Arctic Flying of Captain Wilkins and Lieutenant Eielson, *Science*, No. 1691, Vol. 65, 1927, May 27, pp. 523–525; reference on p. 523.

[8] This expedition is known as the "Detroit News-Wilkins Expedition," from the backing given by the *Detroit News*. The complete report of the expedition is in the files of the American Geographical Society. An extract was published in the *Geogr. Journ.*, Vol. 71, 1928, pp. 160–166.

[9] *Geogr. Rev.*, Vol. 17, 1927, pp. 497–498.

[10] N. H. Heck and J. H. Service: Velocity of Sound in Sea Water, *U. S. Coast and Geodetic Survey Special Publ. No. 108*, Washington, 1924.

giving the velocity for every two degrees centigrade and for every thousandth of salinity in each 200-fathom layer of water. Taking 0° C. and a salinity of 35 per thousand as the values in the table nearest to those observed by Nansen in the bulk of the deep water of the Arctic Sea (cf. *inter alia* "Problems of Polar Research," *Amer. Geogr. Soc. Special Publ. No. 7*, 1928, p. 11), we get a depth of 5458 meters for the 7.3 seconds reading and one of 5419 meters for the 7.25 seconds readings. Taking the mean of these two and adding 2 meters for the depth of the apparatus below the under surface of the ice as reported by Wilkins, there results the value of 5440 meters.[11] This, then, is probably as closely correct a value as it is possible to obtain within the limitations imposed, and it is therefore herewith put forward as the definitive figure for Wilkins' sounding. It has thus been entered on the latest revised edition of Nansen's bathymetric map of the Arctic Basin (*op. cit.*, Pl. I).

Later another flight was made in the direction of Grant Land. Two hundred miles out, however, fog compelled return, and the lateness of the season prohibited further attempts.

The Expedition of 1928

The northeastward flight thus became the first objective of the 1928 expedition.[12] It began at Point Barrow on April 15 at 10 a. m. after a week's delay due to difficulties in take-off with the heavily loaded plane. The route was planned to pass through quite unexplored territory for most of the way and also along a critical portion of the border of the continental shelf as represented upon the bathymetric map by Dr. Fridtjof Nansen in "Problems of Polar Research." The course was set in a direct line to latitude 84° N., longitude 75° W., i. e. to a point north of Grant Land. With the exception of a stretch of some hundred miles between latitude 78° and 80° clear weather permitted close observation of the ground. No indications of land were seen. As regards that region immediately west of Grant Land where the hypothetical Crocker Land was supposed to lie, the despatches report "no sign of islands, leads of open water, ice generally rough and ridged but not heavily pressed as to suggest shallow-water conditions."

At the 84th parallel the plane was headed south until the northern extremity of Grant Land was sighted, 13 hours out from Barrow. Here Wilkins forecast a storm over Spitsbergen and considered the possibility of landing at Cape Columbia, whence, if the flight could

[11] Confirmation of the general correctness of this figure is afforded by Table I in "Tables of the Velocity of Sound in Pure Water and Sea Water for use in Echo-Sounding and Sound-Ranging." Hydrographic Department of the Admiralty, London, 1927.

[12] Captain Wilkins organized his third expedition by the sale of some of his equipment of earlier years, supplemented by moderate contributions from individuals and a contribution from the American Geographical Society.

not be resumed, way could be made through a "hunter's paradise" to the Royal Canadian Mounted Police post at Bache Peninsula. However, he decided to continue and set the course to Spitsbergen, sighted seven hours later. The predicted storm forced a landing on the northwestern extremity of Ice Fiord, Dödmandsören. After

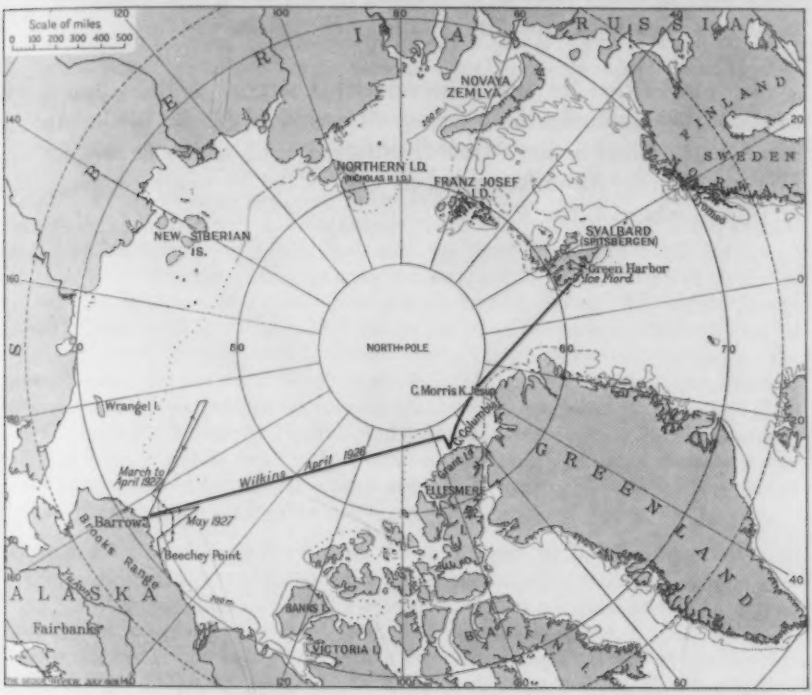

FIG. 1—Map to illustrate Captain Wilkins' flights over the Arctic Basin in 1927 and 1928. Scale 1:50,000,000. The base and the 200-meter bathymetric contour are reduced from Dr. Nansen's "Bathymetric Map of the Arctic Basin" (scale 1:20,000,000) in "Problems of Polar Research," Plate 1, facing p. 14.

being storm-bound for five days, the flight was resumed and a landing made at Green Harbor on the southern side of Ice Fiord. Here is situated the Norwegian Government's wireless station, and near by is the plant of a Dutch coal-mining concession.[13] The general situation of the station is well shown in the topographic map of the concession in the atlas (Oslo, 1927) accompanying the "Report of the Svalbard Commissioner Concerning the Claims to Land in Svalbard" (Copenhagen, 1927), the maps having been constructed under the direction of Dr. Adolf Hoel.

One of the outstanding achievements of the flight is the skill

[13] See Adolf Hoel: The Coal Deposits and Coal Mining of Svalbard (Spitsbergen and Bear Island), *Resultater av de Norske Statsunderstöttede Spitsbergenekspeditioner*, Vol. 1, No. 6, Oslo, 1925. The report includes photographs of Green Harbor: other striking aerial photographs are to be found in Walter Mittelholzer: Im Flugzeug dem Nordpol entgegen, Zurich, 1924.

shown by Captain Wilkins in navigation. Cutting the meridians obliquely meant greatly increasing the problems of navigation and the risk of getting off his course. He comments particularly upon the accuracy of the navigational chart prepared especially for him by the American Geographical Society. The despatches received show that an exceptionally interesting record of ice and weather conditions has been kept, and the detailed description will be awaited with interest.

In recognition of his achievement Captain Wilkins has been awarded the Samuel Finley Breese Morse Gold Medal of the American Geographical Society (see frontispiece), of which he will be the first recipient. Announcement of the award is made on page 496 of this number of the *Review*.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of March and April. At the regular monthly meeting of the Society held at the Engineering Societies' Building, 29 West 39th Street, on March 20, President John H. Finley presiding, Dr. Francis W. Pennell, Curator of Plants of the Academy of Natural Sciences of Philadelphia, gave an illustrated address on "The Andes of Colombia."

At the regular monthly meeting of the Society held at the Engineering Societies' Building, 29 West 39th Street, on April 24, President John H. Finley presiding, Mr. Charles R. Crane spoke on "Moslem Culture in the Yemen and the Hejaz." Mr. Crane, who has traveled extensively in the Near East, in 1926–1927 visited the Red Sea ports. At Jiddah he had an opportunity for first-hand study of the Wahabite movement. He had several interviews with the Emir Feisal, son of Ibn Saud, and he was able to make comparison with the domestic and foreign problems of that ruler and those of the Imam of Yemen whose domain he next visited. The fertile Yemen with its "wonderful terraced valleys where coffee is grown and where the art of agriculture has been developed to a high degree" presents marked contrast to the barren Hejaz. By nature it is extremely isolated, and the policy of the Imam is to preserve that isolation; for his country occupies a highly strategic situation. Mr. Crane entered the Yemen by Hodeida and took up his residence at Sana, the capital on the plateau, where he met "the principal architects, the principal merchants, the military men, and especially the learned men." On leaving Sana he followed one of the ancient caravan routes to Aden.

Special May Meeting of the Society for an Address by Dr. Nansen. A special meeting of the Society was held at the Engineering Societies' Building, 29 West 39th Street, on May 14, when Dr. Fridtjof Nansen delivered a lecture on the "Problems of Arctic Exploration." President John H. Finley presided and in introducing Dr. Nansen referred to his visit of more than thirty years ago. It was at the October meeting of the Society in 1897 that Dr. Nansen received the Cullum Geographical Medal of the Society for his immortal voyage on the *Fram*. In the intervening time much has happened in the Arctic. As Dr. Nansen pointed out in the beginning of his address, the pioneer work of exploration is well on the way to completion, thanks to new methods of exploration. After paying tribute to Captain Wilkins' remarkable flight from Alaska to Spitsbergen, Dr. Nansen discussed the contrast between the new and old methods of Arctic exploration, illustrating with lantern slides and graphic descriptions from the experiences of the *Fram* in 1893–1896. Exploration by airplane is essentially reconnaissance in nature: it must be followed by intensive work done for the most part on the surface, though it may be possible to execute depth soundings from an airship. Among the problems waiting solution Dr. Nansen referred particularly to the determination of the depth and contour of the Arctic Basin; the biology of the North Polar Sea, where interior desertic conditions contrast with luxuriant life on the fringes; the vast importance of the collection of meteorological data; and that little-known phenomenon on which important work has just begun, the aurora. In conclusion Dr. Nansen briefly outlined his own plans for exploration by dirigible in 1929, under the auspices of the International Association for the Exploration of the Arctic by Airship (Aero-Arctic), of which he is president.

Elections to Fellowship. At the March and April meetings of the Society, President Finley presiding, there were presented with the approval of the Council the names of 25 candidates, who were duly elected as Fellows of the Society.

Award of the Samuel Finley Breese Morse Medal to Captain George Hubert Wilkins. At a special meeting of the Council on April 24, the Samuel Finley Breese Morse Gold Medal of the Society was awarded to Captain George Hubert Wilkins in recognition of his Arctic explorations during the past three field seasons. Captain Wilkins' expeditions are briefly described in an article published in this issue of the *Geographical Review*, and the scientific results will appear in a later issue. Announcement of the award was made at a general meeting of the Council and Fellows of the Society on April 24.

The Samuel Finley Breese Morse Medal fund was founded in 1902 by the will of Samuel Finley Breese Morse, the inventor of the telegraph, who died in 1872 (see *Journ. Amer. Geogr. Soc. of New York*, Vol. 4, 1872, p. 52, and *Bull. Amer. Geogr. Soc.*, Vol. 35, 1903, p. 112). In 1926 the fund had reached a size which permitted the Society to devise a medal—the design is by Mrs. Laura Gardin Fraser—and prepare the dies. It is proposed to award the medal every five years for exceptionally distinguished work in geographical research. Photographs of the medal, obverse and reverse, five-eighths the actual size, appear as a frontispiece to this number of the *Geographical Review*. Captain Wilkins is the first recipient of the medal.

Resolution on the Death of Mr. James B. Ford. The following resolution was passed by the Council of the Society at its meeting of April 19.

"James B. Ford, our Vice-President, died on March 29. It is difficult adequately to express the loss thereby sustained by the Society.

"He gave unsparingly of his time in following and assisting in all the varied work of the administration, with an appreciation that lent enthusiasm to all the staff. His benefactions embraced the support of every undertaking by the Society. Thus he provided funds for the prosecution of the great work of mapping the whole of the Central and South American states to conform to the universal standard of one-millionth—an enterprise without precedent for a private institution. The extensive research work, monographs, and collaboration with governmental and other scientific bodies was rendered possible by him; and his private charity relieved illness and misfortune amongst members of the staff when brought to his attention. His bearing was retiring and unemotional, but his nature seemed to respond to personal contact with worthy endeavor or with human suffering.

"The Council desires to record not only the great benefits received by the Society but also to pay its tribute to an individual character of marked distinction and originality. The impress of his long and intimate relation will never be effaced."

Elections to Membership in the Council. At the meeting of the Council of the Society held on April 19 Mr. Charles R. Crane and Dr. Wesley C. Mitchell were elected Councilors of the Class of 1931.

The Death of Mr. Chandler Robbins. Mr. Chandler Robbins, who was elected a Fellow of the Society in 1872, died at his residence in New York on April 25, 1928. Mr. Robbins held several offices during the period of his connection with the Society. He became a Councilor in 1882 and Domestic Corresponding Secretary in 1897. From 1907 to 1913 he was Chairman of the Council, retiring from that body in 1915.

The Death of Mr. Cyrus C. Adams. Mr. Cyrus C. Adams, former editor of the *Bulletin of the American Geographical Society*, died at his home in Queens Borough, New York City, on April 4, 1928, in his eightieth year. Mr. Adams became connected with the Society in 1902 as associate editor, succeeding to the editorship after the death of Mr. G. C. Hurlbut on December 26, 1908, and holding this position until his retirement in 1915.

Mr. Adams' particular interest lay in the dissemination of geographical knowledge. "The cause of popular geography may be pleaded with earnestness and with dignity

by the highest authorities in our study," he said in his presidential address before the Association of American Geographers in 1906 ("Some Phases of Future Geographical Work in America," *Bull. Amer. Geogr. Soc.*, Vol. 39, 1907, pp. 1–12). Long before his association with the Society Mr. Adams had been a keen follower of the progress of geographical discovery and of its applications; while his newspaper experience—he was for many years an editorial writer on the New York *Sun*—was a notable aid to the presentation of his geographical studies. The increase of size in the *Bulletin* under his direction is a reflection of his flair for geographical news. His textbooks, "A Textbook of Commercial Geography" and "An Elementary Commercial Geography," first published in 1901 and 1902 respectively, are distinguished by the use of "instructive" facts as compared with the generalities in vogue in the textbooks of the time. Another instance of his appreciation of the actual fact is his account of "Lieutenant Peary's Arctic Work" in the *Geographical Journal* for 1893. He had access to Peary's notebooks, and much geographical detail in the account of this work in Greenland has not been published elsewhere.

With Mr. Adams' tastes and opportunities it was natural that he should find special interest in African exploration and geography. Many of his magazine articles were on African topics: "Foundations of Economic Progress in Tropical Africa" in the *Bulletin of the American Geographical Society* for 1911 may be instanced.

Mr. Adams was a tireless advocate of the use of good maps for the advancement of geographical education. He wrote and spoke on the subject (see, for instance, "Maps and Map-making," *Bull. Amer. Geogr. Soc.*, Vol. 44, 1912, pp. 194–201) and gave practical exposition of his ideas. He created a department of "New Maps" in the *Bulletin*, of particular value at the time. He was responsible for the organization of an exhibit of foreign map material which, loaned to universities and schools, traveled across the country from Atlantic to Pacific and had a marked influence on the teaching of geography. A step in the campaign for better maps was the production by the Society of a map of the Catskill Mountains on a scale of 1:190,080, printed in color and published in the *Bulletin* for 1907 (opp. 256), "to show our people what a fine atlas sheet, even on a small scale, may be made with topographic sheets of our Geological Survey as a basis." Probably this was the first time that the United States topographic sheets were used for such a purpose.

Mr. Adams was a member of the Association of American Geographers since its foundation, being elected to its council at the organization meeting in 1904. He was also a member of the Washington Academy of Sciences and of the National Institute of Social Sciences.

Recent Publications

The Middle Euphrates: A Topographical Itinerary. Palmyrena: a Topographical Itinerary. These volumes, by Professor Alois Musil, constitute Numbers 3 and 4 respectively of the Society's series *Oriental Explorations and Studies* (see *Geogr. Rev.*, Vol. 15, p. 297; Vol. 17, pp. 145, 178; Vol. 18, p. 144).

"The Middle Euphrates" deals with two expeditions carried out in 1912 and 1915 along both banks of the Euphrates between the great eastward bend of that river and the site of Babylon, as well as in the interior of Mesopotamia. The appendixes contain critical discussions of the probable routes of Xenophon and of Julian the Apostate, reconstructions of medieval trade routes between Baghdad, Kufa, and Syria, an elaborate study of the canals of Babylonia in antiquity and during the Middle Ages, and an examination of the campaign of the Moslem general Khaled ibn al-Walid in the country lying west of the Euphrates.

In "Palmyrena" journeys of 1908, 1912, and 1915 in the territory north and west of the ancient desert city of Palmyra are narrated. The appendixes contain material on the civil and ecclesiastical administration of this region in the early Christian

centuries, on Roman and Arabic routes and stations in Palmyrena, and on the country residences of the Omayyad caliphs. The great ruined and deserted town of Resafa is described in detail and illustrated with sixty-four photographs and drawings.

Map of Southern Mesopotamia 1:1,000,000. This map, printed in black and brown, embodies the results of Professor Alois Musil's explorations of 1912 and 1915 between the Euphrates and the Tigris, as described in his volume "The Middle Euphrates" (see preceding note). The map was compiled in much the same manner as the maps of Northern Arabia and the Northern Hegaz, published by the Society (see *Geogr. Rev.*, Vol. 18, 1928, p. 145).

The Coral Reef Problem. This monograph, giving the results of Professor Davis' matured judgment on the coral reef problem, is based on field work in the Pacific in 1914 with supplementary studies in the Caribbean in 1923 and on an analysis of the very extensive literature of the subject. Professor Davis' main conclusion is that "Darwin's theory of upgrowing reefs on intermittently subsiding foundations, extended by introducing the effects of Glacial changes of sea level and temperature, as proposed by Daly, and by adding such minor modifications as may be called for in special cases, will deservedly regain in the present century the general acceptance which it enjoyed through the middle of the past century."

The volume is in two parts. Part I examines the various theories that have been advanced. Part II presents the facts of the problem. These are taken up regionally—the cooler seas, the marginal belts, and the true coral seas—and discussed from the standpoint of land forms. "Coral reefs must be treated as items in the geological history of their areas; and their history must include a due consideration of the processes of volcanic eruption, land sculpture, and sea-floor deposition, as well as of the changes of island and of ocean level, along with the processes of reef growth." The systematic and thorough physiographic presentation offers a new mode of approach to the problem. The illustrations are another distinguishing feature of the monograph. There are numerous reproductions from charts of the U. S. Hydrographic Office, the U. S. Coast and Geodetic Survey, and the British Admiralty; some fine photographs; numerous sketches; and most particularly that form of illustration for which the author is famous, a series of block diagrams of great beauty and clearness.

The Last Glaciation. Dr. Antevs' volume "The Recession of the Last Ice Sheet in New England" was published in 1922 as No. 11 of the Society's *Research Series*. It was the first successful working out of a glacial chronology in the western hemisphere. Since then Dr. Antevs has continued his investigation of the problem in the United States and Canada. This volume, "The Last Glaciation," summarizes results and compares with those of other investigators in a survey of the fundamental questions of the Ice Age. As Professor J. W. Goldthwait says in his preface, "The patient, accurate measuring of the clay layers, of varves, the plotting and matching of graphs, and the cautious interpreting of these as yearly records of climatic change has been a vital part, yet only a small part, of his work. Equally at home in physiography, Pleistocene botany, and zoölogy, and eager in his study of climates of the past, he has never lost sight of the large geologic and geographic problems . . . and . . . now puts his facts, his elaborate measurements, and his thoughts beside the facts and opinions of the specialists of seven continents."

Expeditions

Return of the American Geographical Society's Peruvian Expedition and of Mr. Joseph H. Sinclair's Expedition to the Ecuadorean Oriente. Announcement of these expeditions to unmapped regions of the Andes in Peru and Ecuador respectively was made in the January number of the *Geographical Review* (p. 144). Both parties

have now returned after successful accomplishment in the field, and the scientific results are being prepared for publication. It is planned to include an account of Mr. Sinclair's expedition in the October number of the *Review*, while the results of the Society's Peruvian expedition by the leader, Mr. O. M. Miller, will appear in the following, January, number.

The Antarctic Expeditions of Commander Byrd and Captain Wilkins. The American Geographical Society has endorsed the plans of the expeditions of both Commander Byrd and Captain Wilkins for scientific exploration in the Antarctic in 1928–1929. The Society has also made a contribution to each expedition.

In a cable dispatch Captain Wilkins asks that the American Geographical Society make the first formal announcement of his plans and comment upon them as it may see fit. The cable reads:

"Expect using Lockheed seaplane now under construction, delivery August, for flight from Ross Sea following coast to Graham Land. Pilot and mechanic yet unchosen. With machine myself take Norwegian whaling ship leaving Panama for Antarctic via Tasmania about November 1, remaining with ship until commencing flight in January ending beside one of forty whalers operating near Graham Land and with whom will return Montevideo May next."

In length the flight will equal or slightly exceed the one just finished from Point Barrow to Spitsbergen. The coast of the Ross Quadrant that it will cover is very little known. Captain Wilkins will photograph the details of ice border, glacial tongues, mountains, and other features visible from his plane. In this way he will be able to select sites for the meteorological stations that he has long planned to establish. By continuous observations at these stations it is hoped to coördinate Antarctic weather conditions with those observed simultaneously in Australia, New Zealand, South America, and South Africa, and establish a sounder basis for long-range weather forecasts.

Commander Byrd, on the other hand, is making not a single long flight but a series of flights, along the line of which a number of supply stations will be laid down for the benefit of the geologist and other specialists who will prosecute detailed studies on the ground. The personnel will also include both a meteorologist and an aerologist, and a number of high altitude flights will be made for the study of weather conditions aloft, upon which light will thus be shed for the first time.

One of the proposed flights is over the South Pole. East and west of this line Commander Byrd will have an opportunity for important geographical discovery. A chain of mountains is known to extend northwest of Ross Sea. Byrd, on one side of this chain, and Wilkins, on the other, ought to give us for the first time knowledge of the longest unexplored mountain chain in the world—the Antarctic continuation of the great Andean Cordillera. By easterly flights from his main polar line of reference, Byrd will also be able to gather information on the continental interior. Of particular interest is the determination as to whether a depression runs across Antarctica from the Ross Sea to the Weddell Sea or whether there is a broad connection between the two principal divisions of land: in other words, as to whether Antarctica is a single great continent or two large islands. The problem has been recently discussed by Sir Douglas Mawson in the American Geographical Society's *Special Publication No. 7*, "Problems of Polar Research." Sir Douglas also hopes in time to make a study of this and other Antarctic problems on a new expedition of his own.

The American Geographical Society is preparing a special map of the Antarctic regions for the use of Byrd's and Wilkins' expeditions. Among other features it will show wind directions and lines of equal magnetic variation, so far as these are known. The scale on which the map is being compiled is approximately 1:3,000,000.

GEOGRAPHICAL RECORD

NORTH AMERICA

Commerce on the Great Lakes and Connecting Waterways. It is of interest at this time when there is much discussion of the commercial potentialities of the Great Lakes-to-Ocean waterways to make a survey of the actualities on the waterways in their present state. An excellent starting point is the volume prepared by the Board of Engineers for Rivers and Harbors of the War Department in coöperation with the United States Shipping Board ("Transportation on the Great Lakes," Washington, 1926). This report presents the physical background of the problem and detailed studies of the grain, ore, coal, and package freight movements on the lakes. It is well supplied with tables, both general and detailed, and with valuable maps showing the movement of the different commodities. Material to supplement and bring this report up to date can be found in the annual reports of the Chief of Engineers, U. S. Army (1927, Part 2) and in the annuals, "Report on the Grain Trade of Canada," published by the Dominion Bureau of Statistics. Useful figures are also to be obtained from the publication "Great Lakes-to-Ocean Waterway," by E. S. Gregg and A. L. Cricher (*Bur. of Foreign and Domestic Commerce, Domestic Commerce Ser. No. 4*, 1927). Graphic representation of wheat and flour traffic on the Great Lakes is presented in the first of the Goode-Baker Series of Economic Wall Maps, "Wheat: Production and Trade (1926)."

Grain entering into the commerce of the Great Lakes comes from sixteen states of the central and northwestern United States and from the three Canadian provinces of Alberta, Saskatchewan, and Manitoba. The four chief shipping centers are Fort William-Port Arthur, Duluth-Superior, Milwaukee, and Chicago. In 1923, 68.6 per cent of the grain exports from the upper lake ports went by water, 31.4 per cent by rail. Wheat comprises the bulk of the grain shipments from the Lake Superior ports and generally goes by water. Corn and oats predominate in the grain movements from Chicago and Milwaukee, and the tendency is to employ rail instead of water transportation.

The volume of grain carried on the Great Lakes increased nearly tenfold between 1868 and 1923, but there has been little appreciable increase in the amount moving from Lake Michigan. This is largely a matter of rates. Chicago with its excellent railroad connections is able to give all-rail rates on grain that compare favorably with the rates that include water transportation to a lower lake port and rail haul to an Atlantic port. Consequently grain from Chicago destined for Atlantic ports tends to move all-rail (Richard Hartshorne: The Significance of Lake Transportation to the Grain Traffic of Chicago, *Econ. Geogr.*, Vol. 2, 1926, pp. 274–291).

A good share of the water-borne grain exports from Chicago goes to Montreal either through the Georgian Bay ports or via the St. Lawrence. Grain from the Chicago hinterland ripens early and can be shipped before the elevators and the port of Montreal become congested with the Canadian crop. Grain traffic on the Great Lakes moves in waves. The first peak occurs as soon as navigation opens in the spring and serves to remove the last year's crop which has been stored in elevators or in ships. The peak of the United States shipments comes in August, closely followed by the Canadian which lasts up to the close of navigation. By the time the Canadian grain enters the field, congestion on the Montreal route, combined with the shorter season of navigation on the St. Lawrence, tends to divert much Canadian grain to United States ports. During the winter, grain stored at the Georgian Bay ports or at Montreal is sent by rail to St. John, Halifax, Portland, or

even Boston. Canadian grain movements are summarized in "The Transportation of Canadian Wheat to the Sea," by L. M. Fair, and "The Port of Montreal," by L. C. Tombs (*McGill Univ. Econ. Studies in the Natl. Problems of Canada, No. 1*, 1925, and *No. 6*, 1926). Buffalo is the chief receiving port for lake grain. Here some is transshipped via the St. Lawrence to Montreal; some goes by rail to Montreal, New York, or other Atlantic ports; and some is converted into flour. New York owes much of its attraction as a grain-shipping port to the great amount of shipping that centers there. Grain is a very desirable dead-weight cargo for liners, and frequently the competition to secure this cargo is such that ocean rates from New York offset any increase in price the rail haul to that port may have made over rates on the Montreal route.

In 1923 ore shipments constituted about 50 per cent of the total volume of traffic on the Great Lakes. The ore mined in the Lake Superior district is hauled a short distance to water and loaded on ore vessels by special apparatus. The bulk of the ore moves from Lake Superior to Lake Erie ports, whence it goes to the steel centers of Ohio and Pennsylvania. An important deflection from this great ore stream is that to the Calumet-Gary district at the southern end of Lake Michigan. Water transportation with its highly organized methods of handling ore permits an average saving of $2.71 a ton over the probable rail rate.

Shipments of coal in 1923 made up about 25 per cent of the volume of lake traffic for that year. Originating in the bituminous fields of the Appalachian trough and the anthracite region of Pennsylvania, this commodity furnishes a west-bound cargo for the grain and ore boats. The ore-receiving ports are not, however, the chief coal-shipping ones. Anthracite is generally sent from Buffalo; and, although Ashtabula, Conneaut, and Cleveland all contribute to the lake flow of bituminous coal, Toledo alone exports 30 per cent of it (Port Study, Toledo [Ohio] Port Commission, 1924). The total coal shipments do not suffice to provide return cargo for all the grain and ore boats; and consequently there is lively competition which, with its attendant reduction in rates, makes it possible for eastern coal to compete in the north-central part of the continent with coal mined in the Middle West, particularly in Illinois. Most of the lake coal moves to Lake Superior ports. The majority of the imports at the Lake Michigan ports are of anthracite or of grades in which Illinois is unable to compete.

A detailed examination of an industrial district adjacent to the Great Lakes throws more light on the commercial significance of the inland waterway. Such a study has been made by Professor J. B. Appleton (*Univ. of Illinois Studies in the Social Sciences*, Vol. 13, No. 2, 1925) for the Calumet iron and steel district, situated near Chicago on the south shore of Lake Michigan. This district supplies, at a lower cost than elsewhere, a little over 20 per cent of the steel produced in the United States.

Quite in contrast to the heavy traffic on the Great Lakes is the lack of activity on adjacent waterways, including the New York Barge Canal. During the navigation season of 1926, 2,400,000 tons moved over the canal, a poor showing for a route connecting the Great Lakes with New York, the chief port of the country. Many reasons for the lack of business on the Barge Canal have been given: goods must be transshipped; transshipment and terminal charges eat up any saving gained by using the canal; traffic is slow; equipment is clumsy; and the navigation season is limited. However, the Barge Canal is becoming better equipped, and its traffic may improve. The new Welland Ship Canal will be large enough to allow most vessels on the Great Lakes to enter Lake Ontario. As a consequence ports like Oswego may regain some of their former importance. It will soon be possible for grain freighters to discharge their cargoes at Oswego instead of Buffalo, whence the trip to New York either by rail or canal is much reduced (see "Great Lakes Commerce and the Port of Oswego, New York, 1925," Report . . . by Fay, Spofford and Thorndike, 2 vols., Harbor and Dock Commission, Oswego, N. Y., 1927).

The Illinois Waterway, to consist of the Sanitary Ship Canal of the Chicago Drainage District and the deepened and canalized sections of the Illinois River, is in some ways a parallel to the New York Barge Canal. Not a great deal of traffic originates along this waterway; the population is scattered; and there are few large towns. Present industries are now well established with reference to rail routes, which are admittedly adequate to handling all the traffic. Miss B. L. Ashton has surveyed the situation in "The Geonomic Aspects of the Illinois Waterway" (*Univ. of Illinois Studies in the Social Sciences*, Vol. 14, No. 2, 1927).

A Reconstruction of the Natural Vegetation of Ohio. In his reconstruction of "The Natural Vegetation of Ohio" (*Ohio Journ. of Sci.*, Vol. 25, 1925, pp. 139–149; Vol. 26, 1926, pp. 128–146, 213–231) Paul Bigelow Sears accomplishes in small compass an ambitious task and one of geographical interest beyond the immediate theme. The method he employs is one that could be applied with success to a study of the soils, land forms, and drainage patterns of the natural landscape wherever survey records are preserved.

Dr. Sears prepared his map of the virgin forest by transcribing the species of bearing trees recorded at section corners in the original land surveys by the early surveyors. It was in Ohio that Thomas Hutchins, first and only "Geographer of the United States of America," inaugurated the use of the so-called township system of land surveys. All corners which lay within the forest were located with reference to near-by trees, the species of which were noted. The Ohio surveys were begun in July, 1786, and were run by trained woodsmen who generally observed and recorded the species correctly and made few serious errors in location. The surveys thus provide the botanist with authentic observations as to the character of the vegetation at the points of intersection of all meridians and parallels, spaced at intervals of a mile.

The reconstructed map of vegetation is correlated with present and preglacial topography and soil with the result that the author ventures the following prophecy. "*There have been no accidents.* In fact, so striking is the relation between preglacial topography and natural vegetation that the writer does not hesitate to express his belief that a great preglacial valley will probably be found running northward through Champaign, Logan, Hardin and Hancock counties." He finds that there were three characteristic species groups within the state, oak (black oak, white oak, hickory, etc.), beech (beech, sugar maple, etc.), and ash (black ash, white ash, elm, maple, etc.), and that these species groups within the glaciated region were primarily correlated with the moraine system. "Broadly speaking, beech tended to appear along the side, ash upon the central ground, and oak toward the central terminal region of the glacial lobes." The prairies, occasionally fairly extensive—embracing from fifty to one hundred square miles, were found to have been edaphic and to have been correlated with the glacial moraines. Prairies were completely absent in unglaciated parts of the state. These were not climatic grasslands nor were they due in any measure to aboriginal firing. The author has located many unforested prairies which had been obscured or destroyed by secondary successions introduced by white men.

C. W. THORNTHWAITE

Mountains of Southeastern Idaho. A comprehensive geological essay on southeastern Idaho by G. R. Mansfield (*U. S. Geol. Survey Professional Paper 152*, 1927) includes many statements of physiographic import, among which the most significant is that which explains the mountain ranges as showing in their highlands the remains of a peneplain developed on a mass of folded, faulted, and overthrust strata when the region stood lower than now; the intermont valleys being the result of dislocations and of erosion while and after the wide-spread peneplain was broadly uplifted. A similar result is announced for many ranges in Siberia by Obruchev

(Geologie von Sibirien, Berlin, 1926), who says that fault-block mountains, the folded structures in which had been greatly eroded after their earlier production, there play the first rôle. Where, then, are any large mountain ranges to be found now in the cycle of erosion that was introduced by the folding of their rocks?

W. M. DAVIS

SOUTH AMERICA

The Peru-Colombia-Brazil Boundary Agreements. As the result of agreements reached in a series of meetings of representatives of the governments of Peru, Colombia, and Brazil, called in Washington in March, 1925, considerable progress has been made toward the settlement of the highly complicated and long-standing boundary disputes involving the counterclaims of Peru, Ecuador, Colombia, and Brazil in the territory east of the Andes between the Caquetá, or Japura, and Amazon rivers.

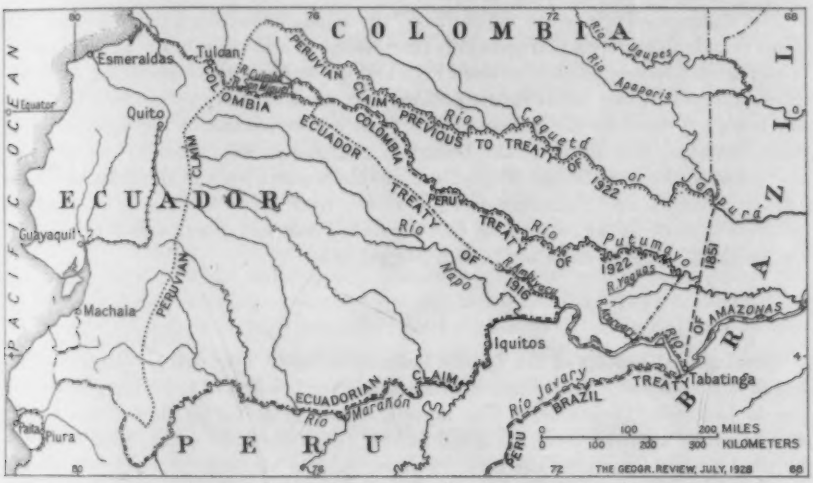

FIG. 1—Sketch map showing the new Colombia-Brazil and Colombia-Peru boundaries and the extent of the counterclaims of Ecuador and Peru. Colombia has relinquished the claim against Brazil to the point of territory between the Putumayo and Amazon rivers east of the Apaporis-Tabatinga line. No mention is made in the Colombia-Peru treaty of the disposition of counterclaims to the territory north of the Colombia-Ecuador boundary of 1916 between the San Miguel-Cuimbé line and the western boundary of the Peruvian claim previous to the treaty. Scale approximately 1:13,000,000.

At these meetings it was agreed on the part of Colombia and Brazil that a treaty would be signed in which Colombia would recognize as her boundary with Brazil the line from Tabatinga on the Amazon River to the mouth of the Apaporis River in the Putumayo River (defined by Peru and Brazil as their common boundary by the treaty of October 23, 1851) and relinquish her claim to the strip of territory between the Putumayo and Amazon rivers east of this line, and in which Brazil, in return, would grant to Colombia freedom of navigation in perpetuity on all navigable streams common to both countries.

It was agreed on behalf of Colombia and Peru that the unratified boundary treaty signed by representatives of these countries on March 24, 1922, would be ratified. This ratification has now been effected, by Colombia on October 30, 1925, and by Peru on December 20, 1927. It defines the boundary as a straight north and south line from the San Miguel, or Sucumbios, River (defined by Colombia and Ecuador by the treaty of July 15, 1916, as forming a part of their common boundary) to the mouth of the Cuimbé River in the Putumayo River; thence down the Putumayo

River to the mouth of the Yaguas River; thence by a straight line from the mouth of the Yaguas River to the mouth of the Atacuary River in the Amazon River; and from there down the Amazon River to the Tabatinga-Apaporis line. Colombia thereby retains a corridor from the Putumayo to the Amazon between the Yaguas-Atacuary line and the Tabatinga-Apaporis line, recognizes the Tabatinga-Apaporis line as her boundary with Brazil, and relinquishes her claims to territory east of it between the Putumayo and Amazon rivers.

Ecuador was not a party to the Washington conferences nor to any of the agreements arrived at by those conferences. The most important of the disputes in the region, that of Ecuador and Peru, is, therefore, still unsettled. As defined by the extreme claims of the two countries, it involves an enormous triangular area bounded by the Colombia-Ecuador boundary of the treaty of 1916, the Marañón River, and the crests of the Eastern Cordillera of the Andes. The dispute is now further complicated by the fact that Colombia has resigned to Peru territory north of the boundary established with Ecuador in 1916.

The Colombia-Peru treaty states that "the high contracting parties declare that there remain definitely and irrevocably terminated all and every one of the differences with regard to the boundary between Peru and Colombia which have arisen up to the present time and that in the future nothing may arise to alter, in any form the line of the boundary fixed by the present treaty." It will be noticed on the accompanying map, however, that north of the boundary established by Colombia and Ecuador and between the Cuimbé-San Miguel line and the western limit of the Peruvian claim against Ecuador and Colombia previous to the 1922 treaty is an area of which no mention is made in the treaty. In fact the treaty does not describe or even mention the boundary west of the Cuimbé-San Miguel line.

EUROPE

Geographical Aspects of the Tourist Industry in Italy. The tourist industry in Italy has of late been made the subject of quantitative studies by the Enit (Ente Nazionale per le Industrie Turistiche). The investigations, in so far as they relate to the movement of tourists, were discussed at the Tenth Italian Geographical Congress by the Director-General of the Enit, Professor Angelo Mariotti (*Atti del X Congresso Geografico Italiano*, Vol. 2, Milan, 1927, pp. 539–550). Tabulations of the number of foreigners registered with the police, of the number of railway tickets sold, and of guest taxes levied upon hotels of the first and second class furnished statistical bases for the studies, but unfortunately—Professor Mariotti is obliged to explain—the figures are incomplete and misleading. They suffice, however, to give a view of the relative, if not of the absolute, flow of tourists to the different provinces of Italy at different times of year. The facts are presented for 1926 in tables and on diagrammatic maps.

Italian and foreign tourists do not flock in proportionately equal numbers to the same regions. Taking 1926 as a whole, Tuscany, Lombardy, Liguria, Lazio (Latium), and Sicily, in the order named, were most visited by Italians; and Sardinia, followed by Umbria, was least popular. The density of foreign tourist traffic was greatest in the northeastern provinces: Venezia Tridentina (including the Italian Tirol), Venezia Giulia (including Istria), and Veneto; Liguria came fourth and was followed by Lazio and Tuscany. Fewest foreigners visited the Abruzzi, Calabria, and Basilicata. It is noteworthy that Lazio, the province which includes Rome, was not the most attractive to tourists either from within or without Italy. Only in December, 1926, did Lazio hold first place in the number of foreign visitors. In January, February, and November, Liguria (i. e. the Italian Riviera) was the favorite resort of the foreigners; in March, April, and September, Venezia Tridentina and from May to August, inclusive, Venezia Giulia stood first; in October Veneto headed the list.

Professor Mariotti stresses the need for similar, but more intensive and exact, studies, since the "movement of foreign tourists . . . . represents the most conspicuous asset on our international account book . . . . " Such studies might well be undertaken for those parts of the United States (northern New England, for example) where the tourist industry is one of the major economic resources of the native population.

The leading Italian organization devoted to the interests of tourists is the Italian Touring Club. Like its Swedish counterpart (see *Geographical Review*, Vol. 13, 1923, pp. 608–612), the Italian organization is carrying on geographical work of high merit (Touring Club Italiano: L'attività geografica del T. C. I. nel triennio 1924–1926: il "Grande Atlante Internazionale del T. C. I.," Milan, 1927). Founded in 1894, the Club has had a phenomenal growth: by 1926 the membership had reached 400,000. "It is not a rash assertion that the only books, other than schoolbooks, which enter a great many Italian households are those of the Touring Club." The publications consist of maps, guides, periodicals, and recently of a superb atlas of the world. The fundamental map of Italy is in 59 sheets and covers the entire kingdom on a scale of 1:250,000. Publication has been undertaken of extremely accurate and beautiful special maps on large scales (1:50,000; 1:25,000) of regions of exceptional interest to the tourist. Sheets for the Dolomites in the vicinity of Cortina d'Ampezzo and for Palermo with the Conca d'Oro have already appeared, and the completion of maps of Monte Rosa and of the Riviera from Genoa to Sestri Levante is announced for 1928. As a memorial to the late Signor L. V. Bertarelli, who held the position of Director-General from 1906 to his death in 1926, the Touring Club has issued a handsome illustrated volume containing reprints of many of Bertarelli's popular and semipopular articles (Touring Club Italiano: L'Italia e il Touring negli scritti di Luigi Vittorio Bertarelli, Milan, 1927). Seven studies deal with the activities of the Club, twenty with people and places. Among the remarkable illustrations are views of Italian hill towns showing the nearly inaccessible sites on which settlements were established in earlier days and where the population still lingers in spite of inconvenience and actual hardship imposed by the difficulty of approach.

Changes in the Frontier of the French Language since 1806. In 1806, under Napoleon, an investigation of the linguistic situation in France was undertaken. Through a questionnaire submitted to the prefects information was accumulated defining the topographical limits of the French tongue. The unpublished original records in the Archives Nationales and Bibliothèque Nationale are discussed by Ferdinand Brunot in the Appendix to Volume 9 of the "Histoire de la langue française" (Paris, 1927). On the basis of Brunot's study, Albert Dauzat presents (*La Nature*, No. 2775, 1927, Dec. 15, pp. 529–535) a succinct statement illustrated with diagrammatic maps of the principal changes that have taken place in the linguistic frontiers since 1806.

Within France, the areas of French speech have in places advanced, and almost nowhere have they fallen back. In the southwest, however, Basque has held its ground more firmly than has Breton in the northwest. French is making steady progress at the expense of Breton, particularly along the coast of the *département* of Morbihan and along the two national highways from Rennes to Brest. Flemish, also, has been pushed back both in France and Belgium. In Lorraine eastward movements of segments of the French-German linguistic border have occurred near Metz and Chateau Salins, owing, perhaps, to the influence of these towns as "foyers de francisation." In this connection, Dauzat observes that "the linguistic boundary here almost never coincides with a geographical boundary; it cuts across valleys, rivers, and great commercial arteries." In Alsace the line has been remarkably stable. "In Switzerland French has fallen back a little on the north before a powerful ethnic pressure; on the south it has absorbed several German-speaking islets in the Valais."

No sharp line can be drawn delimiting the area of French speech on the southeast. Intermediate dialects, Franco-Provençal and Provençal, Piedmontese, and Genoese bridge the gap between French and Italian. As the literary language of the Piedmontese valleys, Italian, which has the advantage of being the national tongue, has been persistently gaining territory at the expense of French.

AFRICA

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On all sides but the east the frontiers of Fezzan are fairly well marked by relief features. On the north the barren, rocky plateau of Hammada el-Homra in Tripolitania falls off to the Saharan sands of Fezzan in a long escarpment that roughly follows the 28th parallel of latitude. Fezzan itself comprises tracts of sand separated by rocky uplands. The population is concentrated in widely separated oases strung along generally northeastward-trending wadies. The climate is typically Saharan: very dry with extreme diurnal ranges of temperature and occasional violent windstorms. Inhabitants of Murzuk asserted that no rain had fallen there since 1866; although Zoli doubts the literal truth of this, he adds: "The boys of Murzuk with whom I talked did not remember ever having seen rain, and they showed that they had no exact conception of what is meant by the term." The maximum daily range of temperature observed during the summer was 36.4° F. (from 78.6° F. to 115° F.). Zoli believes a gradual progressive desiccation of the Sahara is in progress and that Fezzan in classical times was more prosperous than now. The Romans held the province of Phasania mainly because it included magnificent hunting grounds whence wild beasts could be obtained for the circuses and because the population could be drawn upon for slaves. (In a scholarly article in *Boll. Reale Soc. Geogr. Italiana*, Ser. 6, Vol. 5, 1928, pp. 171–213, Dr. Dino Gribaudi discusses the questions of the changes in the climate of Libya during historical times, concluding that the climate "will not prevent this colony in the near future from becoming worthy of its ancient grandeur." The study is confined to the coastal regions, however.)

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In 1914 Murzuk had some 700 inhabitants; including the surrounding oasis, about 1400. Explorers of a half century ago ascribed to it a population of 25,000 or 30,000; but these figures must be exaggerated. From conversations with well-informed old men Zoli concludes that the maximum even in the most flourishing period could not have exceeded 7000. Depopulation and decadence have followed the stopping of the slave trade and the traffic in arms. Furthermore, Saharan commerce is being diverted through the railways and ports of the surrounding European colonies. Formerly a great fair was held each year at Murzuk; for four or five months a temporary population equal to that of the city itself assembled there.

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Like all travelers in the desert Olufsen emphasizes the scarcity of the precipitation but its torrential nature when rain actually falls. The water either evaporates or sinks rapidly into the sand and interstices of the rocks. Thus high rocky plateaus, while excessively dry at the surface, may act as reservoirs, collecting the rain water within them and distributing it to the oases in the low ground around their margins.

Strong gusty winds blow over the desert most of the time, and there is always fine sand in the air. Olufsen gives an exceptionally striking account of the wind storms of the desert, with their clouds of suffocating sand and dust which often menace the traveler's life. The frequent sand whirls, on the other hand, are neither disagreeable nor dangerous, but in their freakish antics provide constant amusement. (O. Olufsen: Mission O. Olufsen au Sahara 1922–23: Le climat du Sahara: Observations météorologiques, Copenhagen, 1926.)

ASIA

Afghanistan in Transformation. A French writer thus characterizes present-day Afghanistan: "a backward country where Oriental and Occidental civilizations fall afoul of one another: here we find seven-ton motor trucks, but no roads to run them on; aircraft, but no mechanics to operate them; an Emir with very modern ideas, governing an indifferent or even restive population; and a great many foreigners suddenly attracted into a country that, five years ago, was totally closed to the outer world" (Raymond Furon: L'Afghanistan: Géographie, histoire, ethnographie, voyages, Paris, 1926). Amanullah Khan, the ruling King (he adopted this title in 1926), succeeded his father in February, 1919. In the following May he embarked upon a war with Great Britain which soon ended in the crushing defeat of the Afghan army. The war was followed, however, in 1919 and 1921 by treaties that were ad-

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vantageous to Afghanistan, whose complete "internal and external independence was recognized." From these treaties and from treaties concluded at about the same time with the Soviet and the Turkish government may be dated the beginnings of Amanullah's attempted modernization of his country (see Arnold Toynbee: Survey of International Affairs 1920–1923, London, 1925, pp. 376–388; *idem:* Survey of International Affairs 1925, Vol. 1, London, 1927, pp. 546–569). His recent visit to Europe is in line with this policy. Lowell Thomas gives a colorful account of the glaring contrasts in the Afghan scene in his "Beyond Khyber Pass" (New York, 1925).

The most serious recent contribution to the geography of Afghanistan is the work of a German scholar, Dr. Emil Trinkler ("Afghanistan: Eine landeskundliche Studie auf Grund des vorhandenen Materials und eigener Beobachtung," *Petermanns Mitt. Ergänzungsheft No. 196*, 1928). In 1923–1924 Dr. Trinkler traveled from Kushk to Herat, Kabul, and Peshawar, with a side trip into the western Hindu Kush, and he has supplemented his observations in the field by an extended examination of the published literature. A valuable collection of rock specimens made by Dr. Oskar von Niedermayer in the course of a German military mission in Afghanistan during the World War was also placed at Dr. Trinkler's disposal. The latter asserts that the microscopic analysis of these specimens at the Petrographic Institute of the University of Munich was "the first investigation of Central Asiatic rocks that has been carried out on a modern basis." The Niedermayer collection was of no little value in the geological interpretation of portions of Afghanistan. Trinkler's monograph is a systematically organized regional study covering physical, biological, and human geography. (An English version of Dr. Trinkler's popular volume "Quer durch Afghanistan," entitled "Through the Heart of Afghanistan" and edited and translated by B. K. Featherstone, is also available.)

In this connection reference may also be made to Oskar von Niedermayer's "Afganistan" (Leipzig, 1924), in which a splendid sequence of photographs constitutes the essential part of the volume.

The Weather and Climate of China. The present widespread interest in China is not limited to the political situation. Many questions are being asked concerning the physical conditions, the floods, the topography, the climate. Two publications on the weather and climate of China have recently appeared. From Dr. Co-ching Chu, of the National Southeastern University of China, comes a six-page "abstract" entitled "A Preliminary Study on the Weather Types of Eastern China." It is based on the daily weather maps issued at Shanghai, Hongkong, Nanking, Tsing-Tao, and Peking from January, 1924, to June, 1926.

Eastern China and the eastern United States have much in common meteorologically and climatically. In fact, in many classifications of the world's climates they are placed in the same subdivision. As Dr. Chu points out, the weather types of the two areas are strikingly similar with two major differences. The Siberian anticyclonic conditions are so well developed and so dominant in winter that very few storms invade Manchuria and northern China in that season. Hence the weather is distinctly more "settled" than it is in the northeastern United States, and the rainfall is very light. On the other hand, in summer the number of typhoons is greater along the coast of South China than is the number of West Indian hurricanes along the coast of the southern and southeastern United States. Therefore the typhoon control of weather changes in southern and central China is more marked than is the hurricane control in this country.

The winter weather types of eastern China are named according to the locations of the anticyclones, while the summer types are designated by the nature and positions of the low-pressure areas. In the warmer months the centers of action change, and the solar control becomes very marked. Indeed, the regular diurnal variation

of the barometer is characteristic, and the weather types tend to persist, varying much less than in winter. Well developed cyclones, so characteristic in the United States and in Europe, are but seldom observed in China. These disturbances are usually "stunted" in their development, at least before they reach Japan. Therefore cyclonic rainfalls are very light, and this is true even in the lower Yangtze Valley, where they attain their maximum development. The reason, according to Dr. Chu, lies in the fact that the Siberian anticyclone is so dominant in winter that no cyclones of any considerable size can exist on the continent. In summer, on the other hand, "the increasing solar control also excludes the possibility of their development."

A summary of the essential facts concerning the climate of China has been given by C. E. Koeppe and N. H. Bangs ("The Climate of China," *Monthly Weather Rev.*, Vol. 56, 1928, pp. 1–7). The monsoons; weak cyclonic storms in the colder months; the typhoons of summer; the topography; the ocean to the east, including the warm Kuro-siwo current, are listed as the dominant climatic controls. The winter monsoon (N. W.) imports low temperatures into the southernmost districts. "All China shivers down to the tips of its toes—even to Hongkong, the world's coldest subtropical city." Shanghai, in the same latitude as Savannah, Ga., is 14° colder in winter than that American city. Hongkong is some 10° colder than Key West, which lies about 3° of latitude farther north. The winter dust storms of Peking, brought by the violent northerly winds, are well known. In summer northern China is warmer in the mean than the corresponding latitudes in the United States, but absolute maxima of 100° or more are rare.

Rainfall is heaviest in summer, when the prevailing winds are southeast and bring in an abundant supply of water vapor, especially where a forced ascent occurs over mountains or in convectional overturns. The winter winds are continental in origin; they are cold and bring little precipitation. Droughts are distressingly frequent in North China and floods in the northeast. Typhoons are unfortunately frequent and are most disastrous on the coast of South China. They fortunately weaken rapidly as they move inland. As in the eastern United States, however, when they travel inland they may assume the characteristics of ordinary extratropical cyclones and, moving northeastward, may cause heavy rains in central and even in northern China.

R. DeC. WARD

AUSTRALASIA AND OCEANIA

A Report on the Newly Created Territory of Central Australia. The Northern Australia Act of 1926 provided for the division of Northern Territory into two portions: the area north of 20° S. latitude being known as North Australia, with seat of government to be established "as soon as practicable at Newcastle Waters," that to the south as Central Australia, with seat of government at Alice Springs.

It is hoped by such a step to inaugurate a greatly needed "programme of progress." In his illuminating "Report on Northern Territory: Development and Administration" (1925), Sir George Buchanan pointed out that the population of the Territory declined from over 5000 to under 3000 in 1910. In 1921 it was 3867, exclusive of full-blooded aboriginals, who are estimated at some 20,000. Administration of the Territory has been expensive: in 1924 the deficit was four times as great as the revenue.

Some interesting figures on the newly created southern division are given by the Government Resident in the first report on his administration (Canberra, 1927). The area of Central Australia is 236,393 square miles; the population 411. There are more than 85,000 head of cattle, more than 15,000 horses, nearly 10,000 goats, more than 6000 sheep, and several hundred camels. In nine years of record the rainfall at Alice Springs ranged from 4.39 inches (1918) and 5.38 (1924) inches to 28.58 (1920) inches. The absolute range of temperature was from 106° F. to 25° F. From

Alice Springs to Adelaide the distance is over 1000 miles; to Sydney 2100 miles; to Perth and Brisbane over 2200 and 2800 miles respectively. The nearest medical assistance is 331 miles away at Oodnadatta. No wonder "the pushing forward of the railway from Oodnadatta to Alice Springs has given the people of these parts fresh heart."

The Resident, however, points out that "the exploitation of the artesian and sub-artesian resources of the country should synchronise with the coming of the railway." He had arrived at his post at an opportune time to judge of such needs. "I found the whole of the country, with the exception of that portion north of Woodford, suffering from severe drought. . . . I started out with camels on a tour of inspection of the settled area comprised in the western district. During the whole of the journey, which occupied three weeks, I was confronted with the same set of circumstances—practically the absence of all surface waters; the country for miles in the vicinity of wells being denuded of fodder, and when feed was available it was useless on account of being too far removed from existing waters. . . . If Central Australia is to take its place as an inland colony, a vigorous policy of water conservation must be carried out."

THE OCEANS

The Geography of the Andaman Sea Basin. Through the eastern part of the Bay of Bengal extends a north-south chain of islands which subdivides the Bay into a larger western part, known as the Bay of Bengal proper, and a smaller eastern part called the Andaman Sea. This smaller sea, lying between the island chain and the mainland of southern Burma and the Malay Peninsula, is the subject of a study by R. B. Seymour Sewell: The Geography of the Andaman Sea Basin (Geographic and Oceanographic Research in Indian Waters, Part I, *Memoirs Asiatic Soc. of Bengal*, Vol. 9, 1925, pp. 1–25).

The island chain, extending in a gentle arc from near the delta of the Irrawaddy River some seven hundred miles to Sumatra, represents the emerged higher parts of a great mountain range forming the western rim of the Andaman Basin. Igneous rocks make up part of the range, but conglomerates and sandstones are present. Extensive deposits of clay, by some regarded as true deep-sea ooze raised from the sea floor by the mountain upheaval, are accepted by the author, following conclusions of Tipper and Oldham, as comparatively shallow-water deposits derived from decomposition of older serpentine rocks.

As the mountain range was upheaved, the Andaman Sea Basin is believed to have subsided, probably in Pliocene or early Pleistocene time, beginning as a shallow basin into which the Irawaddy and other rivers poured their waters. The weight of these waters is regarded as a possible factor in producing the subsidence. That the uplift of the mountain range is still in progress in places is regarded as probable. Uplifted coral reefs are found in many places, terraces of coral limestone to a height of 60 to 80 feet at one point, a cave in weather-worn coral limestone 200 feet above sea level at another. Submerged stumps and other supposed evidences of recent subsidence, as well as certain evidence of coastal stability, are overruled in favor of the theory of a recent elevation of the land or fall of sea level.

The deep channels across the island mountain range, connecting the Andaman Sea with the Bay of Bengal proper, are regarded as lines of fractures cutting the range transversely. Presence of the same kind of rock on both sides of a channel and similar topographic appearance on both sides seem to be accepted as proofs of fracture. Specialists in building land bridges from one land mass to another will be interested in the author's conclusion that the theory of a former land connection between the island and the mainland is open to strong objections.

The islands are bordered by a "continental shelf" of disputed origin. The author regards this feature as due partly to erosion, partly to deposition of sediment, and

partly to outward building of coral banks. Out beyond the shelf, and below it, are ridges and valleys believed to be parts of a stream-eroded land topography carried down to a depth of at least 1100 fathoms. But a deep "gully" off the delta of the Irrawaddy is not accepted as a drowned part of the Irrawaddy Valley; it crosses the newly deposited continental shelf and "must be a new formation due to the deposition of silt and mud along certain definite lines and due to equally definite causes, the most important of which are the effect of mixture between the silt-laden river water and the more saline waters of the sea" and the deflection of the river current by a marine current off its mouth. The asymmetrical cross section of some of the islands, with steeper slope to the east, is thought to support Brouwer's idea of an anticlinal uplift of the mountain range with progressive advance of the anticlinal "wave" from west to east. Such advance should cause continuing uplift of land on the east and corresponding subsidence on the west. Facts are cited which in the author's opinion establish the reality of such changes of level.

It will be evident that the author has in a few pages touched on many difficult problems, some of them highly theoretical. The reader may hesitate to follow him in all of his conclusions, both those representing an effort to evaluate the work of authorities cited and those based on the author's own observations. But one will none the less find value in this résumé of what is known concerning the physical features of the Andaman Sea Basin and in the author's own contributions to our knowledge of the area.

DOUGLAS JOHNSON

PHYSICAL GEOGRAPHY

Three Recent Ecological Studies of Geographical Interest. Three recent investigations of the relations of plant and animal life to environment illustrate some of the many trends in modern ecology that are of obvious geographical interest.

One is a study of the crater plants of Java (F. C. von Faber: Die Kraterpflanzen Javas in physiologisch-ökologischer Beziehung, Weltevreden, 1927). The slopes of the Javan volcanoes are generally forested. At the lower altitudes tropical rain forest is typically developed; near the summits, the climber reaches the "so-called cloud forest with its stunted trees and abundance of mosses and ferns." In and about the craters of the inactive volcanoes, on the lava detrital slopes (Geröllhalde) of the active cones, around the solfataras, and in certain upland bogs (Hochmoore) a very different type of vegetation is found. In spite of differences in the altitude and climate of these various habitats, this second type of vegetation is sufficiently homogeneous to constitute a single association, the "crater association." Where the latter occurs near a solfatara the contrast is marked between the encircling dark and high-trunked rain forest and "the low shrubs and herbs" of the crater association "growing out of a grayish-white or yellowish-white soil and swathed in a veil of steam and sulphurous fumes." Von Faber attributes the distinguishing characteristics of the crater association primarily to edaphic conditions—that is, to the character of the soil—and only secondarily to climatic circumstances. Near the solfataras the principal control over plant growth is to be sought in the effects produced by the chemical gases upon the soil.

Ecological research of more directly practical application is illustrated in two papers dealing with widely divergent environments in the United States. Percy Viosca, Jr., of the Department of Conservation of Louisiana, argues in favor of what he holds to be a more rational policy in relation to the "wet lands" of that state ("Louisiana Wet Lands and the Value of Their Wild Life and Fishery Resources," *Ecology*, Vol. 9, 1928, pp. 216–229). The wet lands—in other words, the swamps, fresh and salt marshes, lakes, and bayous of the Mississippi flood plain and delta—comprise one-third of the total area of Louisiana. Viosca estimates the annual money value of the game, fish, shellfish, furs, alligator hides, frogs, turtles etc., obtained from

them at $20,500,000. In addition, the wet lands possess a great but imponderable value as a recreational area and, from the scientific point of view, as the last resort of many rare varieties of plant and animal life. The construction of navigation and drainage canals and the extension of levees along the main streams has resulted in the lowering of the ground water table under a considerable part of the wet lands and in the lowering of the surface of lakes, bayous, and swamps. The consequent droughts and fires have led to widespread destruction of wild life. This has not only meant a loss in natural resources incommensurate with any gain to agriculture, but has reacted indirectly to the disadvantage of the agricultural population. Pests of mosquitoes and crop-destroying insects have increased with the destruction of a bird and animal life that would have kept them in check if the normal balance of nature had been maintained. Viosca advocates the "restoration of those natural conditions best suited to an abundant marsh, swamp, and aquatic fauna, but under some degree of control at all times . . ."

In the arid lands of our West certain plants do not draw the water indispensable to their growth directly from the atmosphere or surface water but send down their roots to the ground water level. These plants have been studied by O. E. Meinzer, who presents the results of his research in *U. S. Geol. Survey Water-Supply Paper 577*. Some plants go much deeper than others. "With a few exceptions, the greatest depth from which ground water is known to be lifted by plants is about 50 feet." Alfalfa roots, however, have been reported in a mine tunnel in Nevada at 129 feet below the surface. Some plants depend almost altogether on ground water, others do so only in part, others do not do so at all. The utility of familiarity with the habits of different plants in this respect is manifold. Not only does such knowledge enable one to determine "where water supplies may be developed by digging or drilling," but for persons lost in the desert or otherwise in distress the clues furnished by plants "may be a matter of life or death."

GEOGRAPHICAL NEWS

"Arktis," a New Journal for Polar Research. A new quarterly journal dealing with the Polar Regions has appeared as the organ of the International Association for the Exploration of the Arctic by Airship, whose seat is in Berlin. It is entitled *Arktis (Vierteljahrsschrift der internationalen Studiengesellschaft zur Erforschung der Arktis mit dem Luftschiff)*. Dr. Fridtjof Nansen is the editor, and the geographical firm of Justus Perthes are the publishers.

The main aim of Aeroarctic, as the Association is called for short, is to make possible continuous observation of physical phenomena in the Arctic, mainly by means of permanent stations similar to those established in the Polar Regions by international coöperation in the years 1882–1883. As a preliminary the Association originally had in mind a reconnaissance flight by airship across the Arctic Basin and back. This was prior to the *Norge*, Wilkins, and *Italia* flights. The prime object remains, however; and it is hoped to be able to carry it through. The main sponsor of this phase of Aeroarctic's activities is Captain Walther Bruns, former commander of Zeppelin airships.

Arktis has a broader scope than the title suggests, for it deals with the Polar Regions as a whole, Antarctic as well as Arctic. The first number (No. 1–2, 1928) shows an interesting range of material. It contains an introduction by Dr. Nansen and by Dr. Albrecht Penck, of the University of Berlin, and as leading papers the following: Explorations in Novaya Zemlya and the Barents Sea Executed by the Institute for the Exploration of the North, by Professor R. Samoilovich of Leningrad; Le monde vivant dans l'Antarctique, by Professor L. Gain, former member of one of the *Pourquoi Pas?* Antarctic expeditions; A Few Remarks on Exploration of Arctic Eurasia, by Dr. I. Tolmatschow (Tolmachev), formerly curator of the Geological Museum of

the St. Petersburg Academy of Sciences; Aufgaben, Bemannung und Ausrüstung einer wissenschaftlichen Beobachtungsstation auf dem Treibeis bei 1–2 jähriger Überwinterung in der inneren Arktis, by Dr. H. U. Sverdrup of the *Maud* expedition; Die Ermittlung der Winddaten im Luftfahrzeuge, by Captain J. M. Boykow of Berlin. Dr. L. Breitfuss, of the editorial committee, gives a historical account of the origin and development of the Association; and there is a copy of the constitution and a list of members, among whom Germans and Russians at present predominate.

The Association has produced two previous publications dealing with its field of work. "Das Luftschiff als Forschungsmittel in der Arktis" (1924) contains papers on Arctic meteorology and air navigation. The proceedings of the first general meeting of the Association in Berlin on November 9–13, 1926 (*Ergänzungsheft No. 191 zu Petermanns Mitt.*, 1927) contains a number of valuable papers on the same subjects. To both of these publications and their constituent papers frequent reference is made in the American Geographical Society's *Special Publication No. 7*, "Problems of Polar Research" (1928).

OBITUARY

James White. James White, who died in Ottawa on February 26, 1928, at the age of sixty-five, was justly regarded as the foremost authority on Canadian geographical problems. His long service in various departments of the Civil Service of Canada, during the greater part of which he was prominently identified with the investigation of the Dominion's land areas, boundaries, and natural resources, had given him opportunity to acquire a unique and unrivaled fund of knowledge. As Chief Geographer of the Department of the Interior from 1899 to 1909, he was actively identified with the work of the Alaska Boundary Commission. As Technical Adviser to the Minister of Justice, he assisted and prepared the map evidence in connection with the Labrador Boundary dispute between Canada and Newfoundland in 1926. To his enthusiasm and untiring personal effort was due no small share of the credit for bringing to a successful issue the international and interprovincial negotiations which resulted in the adoption by Canada and the United States of the great conservation measure known as the Migratory Birds Convention.

James White's contributions to the technical literature of Canadian geography are many and important. He was responsible for the publication of an 8-sheet map of Canada, on a scale of 35 miles to one inch. He is the author of "Altitudes in Canada" (1901); "Dictionary of Altitudes in Canada" (1903); and of the revised editions of both these works (1915–16); "Place-Names in Quebec" (1910); "Place-Names, Northern Canada" (1910); "Place-Names, Thousand Islands" (1910); "Boundaries and Treaties" (1913). He is also author of "Atlas of Canada" (1906), a work which he regarded as his chief technical contribution. This important work was revised by J. E. Chalifour, his successor in the office of Chief Geographer, and secured jointly for its co-authors the Roquette gold medal of the Geographical Society of France.

A brief biography of Mr. White has been prepared by Mr. Hugh S. Spence of the Department of Mines, Canada. From a copy, kindly sent to the Society, the above obituary has been made.

GEOGRAPHICAL REVIEWS

Geographical Reconstruction of North African History

E. F. Gautier. **L'Islamisation de l'Afrique du Nord: Les siècles obscurs du Maghreb.** 432 pp.; ills., bibliogr., index. Payot, Paris, 1927.

El Maghreb, the "West," is the Arabic term for North Africa. The "obscure centuries" comprise the period between "two Arab invasions, that of the Emirs representing the Caliph, at the end of the seventh century, and that of the Hilalian Bedouins, which began in the middle of the eleventh." The "obscurity" lies in the difficulty of reconstructing and interpreting the history of this period. The Arabic historians whose works serve as our sources had a conception of historical writing very different from that which has prevailed in Europe. For one thing, they were immensely interested in details that to us seem trivial to the highest degree. In the *Roudh el-Qirtas* we are informed of the exact number of bricks used in the arcade of the great mosque at Kairouan; and in connection with the death of the founder of the Almohad dynasty a long paragraph states various conflicting views as to the precise date, whether the 13th or 24th of Ramadan, 424 A. H.; no attempt is made to pass judgment on the ruler's work or even to summarize his achievements. Ibn Khaldun in his famous *Prolegomena* reveals a broader view of the function of the historian, a more synthetic method, and a more mature philosophy of history; but he lived over three hundred years after the close of the "obscure centuries."

Our first thought is: Why has Professor Gautier, a geographer, chosen to study "the obscure centuries of Maghreb"? What business has he to trespass in this domain of the Arabists?

The book is a brilliant answer to these questions. Obscure as they are, the seventh to the eleventh centuries were extremely critical ones in North African history. "The Maghreb underwent the most profoundly intimate change that it is possible to imagine. It was transformed in its religion, in its language, in its very soul. The depth of this transformation suffices to explain the general silence" of the contemporary record. It also explains, but does not altogether justify, the tendency of modern scholars to separate the history of North Africa into "two water-tight compartments. There is no communication between the compartment of classical studies" which have shed much light upon the North Africa of ancient times "and that of the Orientalists" equipped to interpret the Maghreb of the Middle Ages. Were there no connection whatever between the classical North Africa and the Islamic Maghreb this segregation might be excused. The natural environment, however, did not change and the population remained at bottom the same, despite the mighty religious and linguistic movements of the "obscure centuries." In his search for clues to the interpretation of the "obscure centuries," therefore, Gautier found it necessary to look far back into classical times. Indeed, he devotes nearly half of his book to the pre-Islamic period; the work, in reality, is a general outline of the whole history of the Atlas countries.

Professor Gautier tells a long and intricate story by piecing together scraps of evidence drawn from archeology, zoölogy, geography, and history and by reading between the lines of the Arabic authorities. Three or four points will suffice to illustrate his method and point of view.

"Here is the problem that dominates the entire history of the Maghreb, that reappears on every page. In our European national histories the central idea is

always the same: by what successive stages has the state, or nation, grown? In the Maghreb, inversely, the central idea is: Through what chain of particular fiascos has the total fiasco been reached?" In other words, throughout North African history no lasting state or nation based on the indigenous population has ever been successfully established. Foreign masters have followed one another in almost uninterrupted succession since the arrival of the Punic founders of Carthage. Disunion shows itself in the mutual hostility of country and city. Professor Gautier likens the city of Fez to an army of occupation quartered in a foreign land from which it draws its provisions but with which, unlike the European capitals, it has no ties of mutual interest or sympathy. One possible explanation of this perpetual disunion may be found in the physical circumstances of North Africa. A chain of plateaus and upland plains extending east and west offers a wonderful avenue for nomadic raiders and conquerors. "Along this artery the poison of conquest has circulated with surprising rapidity through the entire organism, from the Atlantic to the Syrtes or vice versa."

In spite of the reputation of North Africa as one of the granaries of Rome, Professor Gautier believes that the region was very thinly populated at the beginning of the Roman period. Ancient historians frequently mention elephants, although these animals are now extinct. They probably formed part of a relict tropical fauna that has survived profound changes in climate. Their extinction Gautier attributes not to climatic agencies but to a great increase in population under the Romans.

The Maghreb now constitutes part of that great arid belt in the Old World throughout which the population is divided into two mutually hostile groups: nomads and settled folk. This dualism in North Africa first manifested itself as a result of the introduction of the camel, towards the end of the Roman régime. Before the camel was brought from Asia the steppes along the southern fringes of the Atlas and the Sahara were almost uninhabited wildernesses lying beyond the Roman *limes*. The coming of the camels made possible not only the occupation of this frontier region but also the settling of the oases in the heart of the desert. With the adoption by certain of the Berber tribes of a nomadic life based on the camel the cleavage of the North African population into two distinct groups became permanent, and the thread on which almost the entire history of the Maghreb may be strung is the record of the struggles between the nomad camel riders and the settlers. Thus the agriculturist Beranes or Sanhaja of the Middle Ages were the ancestors of the Berber-speaking Kabyles of modern times, and the medieval Botr or Zenata were the progenitors of the modern nomadic "Arabs" of the steppes and desert. While it is true that a certain amount of Arabian blood, as well as Arabic customs and speech, was brought in by the Bedouin tribesmen migrating from northern Arabia with their women and children in the eleventh century, Professor Gautier thinks that the North African nomads of today are essentially Arabicized Berbers.

According to Ibn Khaldun, whose theory reflects the "universal sentiment of the Orient," most powerful among men are the semi-savage nomads who, bound to no particular territory, are free to wander to and fro preying upon settlements. Ibn Khaldun held (as Gautier interprets his views) that "what gives to an Oriental state its area and its bounds is not the nature of the soil or the existence of natural frontiers but the numerical power of the tribe that has furnished the dynasty." This view of the nature of the state, and with it of historical values, is entirely alien to the view that has prevailed in Europe since the time of the early Greeks. The Orientals seem to lack any geographical concept of a nation. They think in terms of race or family or genealogy, rather than in terms of territory. Patriotism is at bottom a geographical sentiment. Its place is taken among the Arabs by *esprit de corps*. This adds a peculiar difficulty to the interpretation of history as recorded by Oriental writers. Professor Gautier's main task, therefore, has been to supply for the Arabic historical sources, and particularly for Ibn Khaldun, the substratum of geography

that will render them intelligible to the Occidental mind. It is especially in this skillful use of geography as an aid to the reconstruction of history that the author shows his characteristic originality. Neither a classicist nor an Arabic scholar, Professor Gautier frankly admits that his undertaking is "très particulière, dangereuse, en dehors des méthodes usuelles de l'érudition." This, however, makes the volume all the more stimulating.

Impressions of the Sahara

Angus Buchanan. **Sahara.** xv and 301 pp.; map, ills., index. D. Appleton & Co., New York, 1926. 9 x 6 inches.

The present book, although it centers around Captain Buchanan's great journey across the Sahara from south to north in 1922–1923, is not a narrative of experiences day by day but a group of short essays, stories, and anecdotes interpretative of the great desert and of the life of the people that dwell within it. The keynote is the decay of the Sahara: rocks are crumbling into sand, oases reverting to the wilderness, people either dying out or losing their morale.

Captain Buchanan points out relations between the inhabitants and the land in which they dwell. The Tuaregs of the isolated mountains of Aïr far to the south are a wild and somewhat timid folk, whereas those of the Ergs, or open tracts of sand dune country, are daring raiders. Indeed, the northern Tuaregs as a whole are bolder than their southern brothers. "In the bazaars of In-Salah, Ouargla and Biskra they have learned of the ways of a bold living world." The cleavage between oasis dweller and desert rover is as marked in the Sahara as in Arabia and central Asia (see *Geogr. Rev.*, Vol. 17, 1927, pp. 514–515). The nomadic or semi-nomadic Tuaregs are the dominant folk, the owners and masters of the oases with their gardens and sedentary tillers of the soil. The hard work in the oases is done, for the most part, by negro slaves brought from the south. The truly nomadic Tuaregs occupy widely scattered encampments, in this respect differing from the Bedouins of Arabia who migrate in tribal groups. Buchanan points out that a half dozen huts may be clustered together "where the head of a family is located, then a few other families perhaps miles apart. It is the economic necessity to be within reach of grazing for their live stock which causes this isolated method of camping. Sometimes food is so very scarce that a single family is the sole occupant of a wide area."

Various incidents and aspects of the desert are described: for instance, the sand storms, the sudden torrential downpours of rain that come at rare intervals, a remarkable caravan of no less than 7000 camels that every year crosses a stretch of three hundred miles of sand eastward from Aïr to obtain salt for distribution among the people of the Sudan, an extraordinary town (Fachi) built almost entirely of blocks of rock salt. Buchanan is extremely successful in conveying to the reader the emotional effect which the desert exerts upon the traveler's mind. On the whole he knows how to write so well and with such genuine feeling that we may look with indulgence upon a pardonable overemphasis of the "mysteriousness," the "sadness," and the "mystic" qualities of the Sahara.

The French Colony of the Niger

Maurice Abadie. **La Colonie du Niger.** 466 pp.; maps, ills., bibliogr., index. Société d'Éditions Géographique, Maritimes et Coloniales, Paris, 1927. 10½ x 8 inches.

The Niger Colony, located between latitudes 12° and 24° N., provides the student with an interesting cross section of the Sudan and the Sahara in one of their least-known parts.

This recent volume is a scholarly piece of work; lucid, simply written, concise, yet

exhaustively thorough. Above all, it is to be commended for its systematic arrangement and treatment and its excellent illustrations. The book is divided into four parts: Part I, "The Physical Description," contains chapters on geology, hydrography, and climatology; Part II, "The Peoples," includes chapters on the origin and history of the peoples: the black tribes, the white tribes, the languages, institutions, religions, mores, etc.; Part III, "The Political Economy," deals with flora and fauna together with the activities based on them; agriculture, pastoral activities, industry and commerce; Part IV, "Organization and Administration," includes chapters on exploration, conquest and occupation by the French, military and civil organization, communications, etc.

The Colony of the Niger has been called the "Benjamin of the colonies of France," its acquisition and occupation dating only from 1897. The area was at first placed under French military rule, but by degrees it has, after several changes of shape, size, and form of administration, achieved civil rights and government. On October 13, 1922, it was elevated to the rank of a colony, and in 1926 its capital was permanently fixed at Niamey. After many interesting episodes of political geography, its limits have finally been fixed. From Nigeria on the south it extends northward through twelve degrees of latitude to the Fezzan extension of Italian Tripoli. From the Tibesti Highlands and Lake Chad it reaches westward to the Niger River. These frontiers enclose a very heterogeneous area of almost 980,000 square kilometers—nearly twice the size of France.

The colony is readily divisible into three natural zones. The Sudanese zone includes the narrow strip of territory in the south, adjoining the Niger River, the British Colony of Nigeria, and Lake Chad and containing most of the large towns of the colony—Niamey, Gaya, Tahoua, Zinder, Goure, and N'Guigmi. This is the zone of fairly regular annual rainfall, which supports a vegetation of heavy savana grass, browse, and baobab trees. The various Negro peoples here are mainly occupied with agriculture, both irrigated and dry-land culture, with cattle raising, and with some fishing along the streams and permanent lakes.

The Sahelian zone includes the plains to the north of the Sudanese zone together with the highland oases of Aïr, Jado, and Tibesti. The irregular light rains support only low, semidesert grasses, with occasional dum palms and gum trees in the basins. This is the pastoral zone of the colony, but there may be found occasional intensively cultivated and irrigated garden patches. Much hunting is also carried on, for the natives find a ready market for plumes, horns, skins, and hides. The sedentary Tuaregs of Aïr disprove the often asserted statement that nomads are such by choice, for many formerly nomadic Tuaregs now cultivate, irrigate, and manure the valleys of Aïr with all the intelligence, fervor, and love for the earth manifested by the peasantry in France. They have, indeed, won the Colonial Award for achievement in agriculture.

The Saharan zone has extremely rare and irregular rains that support a vegetation of small grasses, thorny growths, and salt bushes. These forms are concentrated in the depressions, leaving much of the surface completely barren. Owing to the apparent desiccation of this part of Africa, the Saharan zone seems to be slowly encroaching on the Sahelian zone. This zone is occupied only by a very sparse population of nomadic Tuaregs, Tibbus, and Arabs, engaged in camel breeding, salt making, and desert commerce.

The census in 1925 showed a population of slightly more than 1,000,000. An exact census is, however, impossible because of the mobility of the tribes. Then, too, the population is subject to violent fluctuations because of epidemics of typhoid, spinal meningitis, etc. One epidemic, lasting from October, 1924, to April, 1925, carried off nearly 100,000 persons. If the high infant mortality, due to poor living quarters and lack of hygiene, be added, it is evident that, notwithstanding the high birth rate, the population is likely to remain practically stationary. This figure of

1,000,000 inhabitants gives an average density of 1 per square kilometer, but this varies from 60 in the Sudanese zone to 8 or 10 in the Sahel and almost 0 in the Sahara.

Another deterrent to the development of the Colony of the Niger is the great distances involved in communication and transportation within the colony itself and in relation to its neighbors. It is 1400 kilometers from Niamey to N'Guigmi, located in the southwest and southeast corners of the colony respectively. In Europe, this is the distance from Paris to Lisbon. By caravan, this trip requires 75 days including stops. From Gaya to Bordai is 1800 kilometers (Paris to Bucharest), which requires 112 days of travel and rest.

Much of the colony's commercial poverty results from the difficulty in exporting its products to outside markets. From Zinder it is 300 kilometers to the end of the railroad in Nigeria, while from Gaya it is 484 kilometers to the end of the railroad in Dahomey. Within the colony itself Niamey might starve while N'Guigmi or Zinder possesses a surplus. The cattle which are able to walk across the border in Nigeria find a constant and easily reached market.

In the words of the author: "The prospects of the future of the Colonie du Niger would appear to be *relatively modest.* Certain regions of the colony, the Niger Valley particularly, while not 'sands where Gallic cock loves to scratch,' are populous and rich enough to be fairly able by the action of our administrators, our industry, our colonists, and our merchants, to undergo a remarkable development and to retrieve the prosperity they formerly enjoyed."

G. T. RENNER

OUR UNITED STATES

A. P. BRIGHAM. **The United States of America: Studies in Physical, Regional, Industrial, and Human Geography.** x and 308 pp.; maps, bibliogrs., index. University of London Press, Ltd., London, 1927. 8s. 6d. 9 x 6 inches.

DOUGLAS W. JOHNSON. **Paysages et problèmes géographiques de la terre américaine.** With preface by Emmanuel de Martonne. 248 pp.; maps, diagrs., ills., bibliogr. Payot, Paris, 1927. 40 fr. 10 x 7 inches.

These two volumes have a somewhat unusual interest in that both deal with aspects of the United States as presented by an American geographer to a foreign audience. Professor Brigham's volume, the wider in scope, is based primarily on a course of lectures given at the University of London in 1924, supplemented from lectures given on other occasions at Oxford University. Professor Johnson's volume is physiographic and includes lectures given in various French universities while he was acting as exchange professor in 1923. By their great gifts of clear and interesting exposition both authors are eminently fitted to the task in hand.

Professor Brigham's book "may be used by schools, reading circles, and by the general reader on either side of the Atlantic." It bears mark of the circumstances of its origin, notably in the last three and most striking of the chapters, with their keynote of the fundamental importance of the Anglo-Saxon tradition in America. In "Traditions and Language" Professor Brigham sounds "a warning against half truths" and against vague and facile generalizations pointing to the "shallowness and failure to reach the heart of things, in most of what we say about geographic influence." "The Statehood Complex" deals with the diversities in the country; their successful combination appears in "National Unity."

"The love of the scientist for the researches to which he has devoted his life, an enthusiasm for the spectacles of nature and the problems of their interpretation animate the descriptions and interpretations of geographic landscapes of the United States with something of the youth and sentiment that is the cachet of the American temperament," says Professor de Martonne of the first part of Professor Johnson's volume, dealing with some typical American landscapes. Accompanied by a repre-

sentative selection of photographic illustrations this forms an excellent introduction to the subject with which it deals. The second part of the volume takes up various physiographic problems—the rectilinear shore lines of New England and Acadia, the origin of the Gulf of Maine, river capture in the Appalachians, and a chapter in a neglected field—the application of physiographic principles in legal problems.

Soils and Settlement in Wisconsin

A. R. Whitson. **Soils of Wisconsin.** x and 270 pp.; maps, ills., index. *Wisconsin Geol. and Nat. Hist. Survey Bull. No. 68, Soil Ser. No. 49,* Madison, 1927. 9½ x 7 inches.

Joseph Schafer. **Four Wisconsin Counties, Prairie and Forest.** vii and 429 pp.; maps, diagrs., index. (Wisconsin Domesday Book, General Studies, Vol. 2.) State Hist. Soc. of Wisconsin, Madison, 1927. 8½ x 6 inches.

Professor Whitson has prepared a popular report on the soils of Wisconsin, accompanied by a general soil map of the state. Dr. Schafer, superintendent of the State Historical Society, has added another title to his already long list of publications on the local history of Wisconsin. The former is intentionally general and popular, and the latter more pretentious and academic. A critical evaluation of these works is left, respectively, to the soil technologist and the historian; but they contain sections that will be of use to geographers.

Dr. Whitson's report presents the long-awaited soil map of Wisconsin. It is a synthesis of the soil data slowly acquired by the detailed survey of the several counties. While the detailed work is not complete, it has progressed far enough to permit construction of this general map which, reproduced on the scale of ten miles to the inch and in color, is the outstanding contribution of the volume.

The text is divided into eleven chapters. The first three constitute a primer on soils, designed to introduce the reader to the problem of soil classification. A single chapter is devoted to each of the eight major soil provinces. Here the geographer will find some of the fundamental reasons that explain the varying agricultural prosperity from region to region and from farm to farm. The book is illustrated by well-chosen photographs and by several detailed soil maps reproduced in black and white. Some of the latter, because of poor drafting, blur the page rather than illuminate the text.

The work of Dr. Schafer treats of a more restricted area than the report on soil and appears to have been designed more for the scholar than the general reader. This is the third publication in the Domesday Book Series. Volume 1 of the "General Studies," entitled "The History of Agriculture in Wisconsin" (1922), constituted an introduction to "The Domesday Book Town Studies" (1924). The volume under review contrasts Kenosha and Racine counties, characterized by extensive prairies, with Milwaukee and Ozaukee counties, where the land was heavily forested. This circumstance of nature has created an interesting problem in historical geography, to which Dr. Schafer has made a notable contribution. The prairie counties were settled largely by early American stock and more recent immigrants from the British Isles. The forested counties were completely occupied by the influx of German immigrants who came to Wisconsin in large numbers just after 1848.

From the early land entries Dr. Schafer has observed the fear of the first farmers of the open prairies; he has noted that the low marshlands remained in the hands of the government five to ten years longer than did the well-drained areas; and everywhere the proximity to markets was the primary consideration of the pioneers in the choice of farms. Chapter 6, entitled "The Selection of Farm Land," is short but is characterized by its geographic quality. Chapter 8, on the "Political History," will prove a valuable source of information to those interested in the geography of

politics. One example will suffice as an illustration. In 1856 the two northern, forested, German-settled counties were intensely Democratic and at the Presidential election returned pluralities in favor of James Buchanan, the Democratic candidate. The two southern, prairie, Yankee-settled counties returned Republican majorities for Frémont.

GUY-HAROLD SMITH

A NEW EDITION OF ANDREE'S GEOGRAPHY OF WORLD TRADE

FRANZ HEIDERICH, HERMANN LEITER, ROBERT SIEGER, edits. **Geographie des Welthandels: Eine wirtschaftsgeographische Erdbeschreibung.** Vol. 1, **Europa.** By 17 authors. xx and 1178 pp.; maps, bibliogr.; Vol. 2, **Die Aussereuropäschen Länder.** By 10 authors. xvi and 1110 pp.; maps, bibliogr. L. W. Seidel & Son, Vienna, 1926, 1927. $9.00, paper; $10.00, linen; $11.50, half leather, per volume. 10 x 7 inches.

In this post-war revision of an encyclopedic work, German thoroughness again exemplifies itself. It constitutes a mine of information to which one may turn for reliable reference.

Volume I, dealing with Europe, is divided into four parts, Central, Western, Southern, and Baltic and Northern. The sections are discussed as regional units, followed by a presentation of the geographic details of each political unit within the region. Each country receives systematic treatment, not according to a set program common to all, but rather according to a sequence of topics which allows of adaptation to the respective countries. The scheme is justifiable, it seems to the reviewer, because economic and commercial statistics are available by countries and exceedingly difficult, if not oftentimes utterly impossible to tabulate, by regions. Again, the interpretation of trade movements is subject to grave error if trade treaties, tariffs, nationalistic antipathies, and other critically influential elements are ignored. Two countries may have surpluses of similar commodities and consequently, in theory, have similar potential markets; but numerous elements, as just indicated, may offer sufficient resistance to the flow of trade in either of the two instances as to induce distinctly different trade channels. Nevertheless, that the authors appreciate the significance of regional conditions upon commerce is frequently illustrated.

In a treatise so inclusive as to subject matter, space limitations preclude an exhaustive discussion of each topic. It does seem, however, that since the text focuses upon commercial geography, more space might have been devoted to the activities of the cities. This could have been accomplished by a reduction in the space allotted to the physiographic and geologic details. The latter seem less essential to an understanding of the commercial development of a region than the cities which represent the climax expression of a country's economic and commercial development. For example, one paragraph is given over to Berlin while several paragraphs, touching upon the physical aspects of its hinterland, appear in the discussion of the North German lowland.

The maps do not approach the excellence for which German cartographers have so long been known. This may be due to the increased post-war cost of production, particularly at a time when strict economy had to be practiced. One cannot avoid noting the persistence of German authors and publishers in indicating upon their maps pre-war German territory. It would seem to be better to eliminate such reference unless the map has this specific purpose as its objective.

The second volume maintains the same high standard set by Volume I and has a similar objective. It aims to direct attention to fundamental changes effected among the non-European countries since the Great War and, after appraising the current situation, to estimate the future commercial destiny of the respective countries. Since the publication of Volume I and the completion of the manuscript for Volume II,

two of the guiding spirits of the entire work have passed away—Franz Heiderich and Robert Sieger. The volumes may well stand as worthy monuments to their memory.

Volume II is naturally less intensive in treatment than Volume I. One is impressed, however, by the amount of detail and the accompanying interpretation in view of the necessarily limited acquaintance of the authors with the regions. The volume possesses so much of good that one hesitates to point out defects; yet the reviewer cannot refrain from commenting upon the emphasis given to non-commercial factors, when the title warrants one in anticipating *commerce* as the major theme. On the title page the modifying words, "eine wirtschaftsgeographische Erdbeschreibung" may be intended as more truly representing the authors' objective than the title itself, which clearly focuses attention upon world trade. In this event the presentation is consistent. In any case, the two volumes constitute an excellent survey of the economic conditions over the earth.

EUGENE VAN CLEEF

SOME RECENT EDITIONS OF MARCO POLO

LUIGI FOSCOLO BENEDETTO, edit. **Marco Polo: Il milione.** Prima edizione integrale . . . sotto il patronato della città di Venezia. (Comitato Geografico Nazionale Italiano Pubblicazione No. 3.) ccxxi and 283 pp.; ills., index. Leo S. Olschki, Florence, 1928. 14 x 10 inches.

MANUEL KOMROFF, edit. **The Travels of Marco Polo [the Venetian].** Revised from Marsden's translation and edited with introduction. 2nd edit. xxxii and 370 pp.; index. Boni & Liveright, New York, 1926.

The Travels of Marco Polo the Venetian. With an Introduction by John Masefield. Fully illustrated with twenty drawings in pen and ink by Adrian de Friston and eleven photogravure plates. A reprint of the Marsden-Wright edition. xvii and 461 pp.; maps, ills., index. J. M. Dent & Sons Limited, London and Toronto; E. P. Dutton & Co., New York, 1926.

GEORGE B. PARKS, edit. **The Book of Ser Marco Polo the Venetian Concerning the Kingdoms and Marvels of the East.** (The Modern Readers' Series.) xxxiii and 392 pp.; maps. The Macmillan Company, New York, 1927.

A. J. H. CHARIGNON, edit. **Le livre de Marco Polo,** citoyen de Venise, haut fonctionnaire à la cour de Koubilai-Khan, généralissime des armées mongoles, gouverneur de province, ambassadeur du Grand Khan vers l'Indo-Chine, les Indes, la Perse et les royaumes Chrétiens d'Occident, rédigé en français sous la dictée de l'auteur en 1295 par Rusticien de Pise, revu et corrigé, par Marco Polo lui-même, en 1307, publié par G. Pauthier en 1867, traduit en français moderne et annoté d'après les sources chinoises. Vol. 1. vii and 269 pp. Albert Nachbaur, Pekin, 1924.

Almost as fascinating as the journey of Marco Polo itself is the history of Marco Polo's book since the time when Rustichello of Pisa wrote it down in French while the two men were prisoners in Genoa. The influence of the book on the development of geographical ideas; the direct and indirect effect of the theories derived from it on the progress of exploration; the extent to which Polo's revelation of immense lands and mature civilizations beyond the narrow horizon of the West may have contributed to the broadening of the intellectual outlook of late medieval Europe; the continued popularity of Marco Polo and the place that the study of his travels has taken in modern scholarship—the mere statement of these problems will suggest some of the many paths that allure the historian of the so-called "Milione."

The central core of this history is the record of the text. We do not possess the original version as written by Rustichello. In the long process of copying, recopying,

and translating by medieval scribes portions were dropped out or changed, and additions were made. The relative value of the existing manuscripts and early printed versions, therefore, has become a subject of dispute among students, and the principal modern editions are based upon widely differing texts. Of the recent editions listed above all but that of Benedetto are essentially reprints of well-known texts of nineteenth century scholars.

Komroff's edition and that published by Dent—like the edition in Everyman's Library—make use of Thomas Wright's revision (1854) of William Marsden's English translation (1818) of the Latin version published by G. B. Ramusio in the middle of the sixteenth century. The Dent edition, although attractively illustrated and containing an introduction by John Masefield, is merely a reprint of the Marsden-Wright translation; the footnotes being the same as those of the 1854 edition, the reader of this edition will gain no idea of the important work done by later scholars—such as Pauthier, Yule, and Cordier—in commenting upon Polo's work. Komroff omits footnotes; he occasionally corrects Marsden's translation in order to bring the meaning into accord with that of Yule's edition; and he numbers the chapters as Yule numbers them. Parks's text is based on Sir Henry Yule's famous English translation. The elaborate commentary, in which Yule and Henri Cordier both draw upon their vast store of knowledge of the medieval and modern Orient, is omitted, as the book, like Komroff's version, is intended for the general reader.

Charignon's edition is a translation into modern French of the old French text published by Pauthier in 1867; in the notes the editor quotes extensively from both Yule's and Pauthier's commentaries and also adds the results of his own studies of the Chinese sources.

Benedetto's work far surpasses in significance any of the other four volumes under review. The introduction (221 large pages) gives an elaborate analysis of the entire textual question based on the examination of over 130 manuscripts. This introduction is followed by the first genuinely critical text of the "Milione" that has ever been printed, the first text constructed in accordance with the high standards of modern textual criticism. There is no commentary, except in so far as it relates to the text.

Benedetto's work must serve as the foundation for all serious future studies of Marco Polo. For many years the impression has prevailed that Yule and Cordier did practically all there was to be done in this field. Benedetto shows the falsity of this idea. Not only has he brought to light new manuscripts containing data of unquestioned Polian provenance, but through comparative investigations he has been able to estimate the relative authenticity of the different parts of hitherto well-known texts. The danger no longer exists, as in the past, of the scholar's wasting "treasures of erudition in illustrating, not the thought of Marco Polo, but the errors of his copyists." As a result of Benedetto's work the need now arises for a wholly new English translation.

Man in "The Corridors of Time"

Harold Peake and H. J. Fleure. **Apes and Men.** vi and 138 pp.; maps, diagrs., ills., bibliogrs., index (The Corridors of Time, I). **Hunters and Artists.** vi and 154 pp.; maps, ills., bibliogr., index (The Corridors of Time, II). **Peasants and Potters.** v and 152 pp.; maps, ills., bibliogr., index (The Corridors of Time, III). **Priests and Kings.** 208 pp.; maps, ills., bibliogr., index (The Corridors of Time, IV). Yale University Press, New Haven; Oxford University Press, London, 1927. $2.00 per volume. 8 x 5½ inches.

Whenever one turns to the human problem one begins to think in terms of geography and time. One knows where to look for reference to an outline of the land base and the environmental settings to human habitats; but when it comes to a

matter of sequence in time, or an outline of man's career upon this land base, one may well be at a loss where to look for a summary statement. In theory, archeology is prehistoric history and should be continuous with it; but, for reasons not necessary to state, archeology and history are treated separately, and their coördination has scarcely passed beyond the controversial stage. This need for coördination our authors have sought to meet in their "Corridors of Time." As they see it, the interpretation of human culture is one of the most important problems of our time and they believe that the approach lies in chronology, or the extension of the historical point of view far back beyond the origin of writing. So they have set out to present in concise form the present state of geographical and historic research for the period between man's first appearance and 2500 B.C. Each volume is accompanied by chronological tables, diagrams, and sketch maps executed with a view toward ready accessibility and clarity. Four other volumes, to be published shortly, will deal with the spread of civilization and especially with developments in Western Europe.

Quite appropriately, the first volume "Apes and Men," begins with a review of man's beliefs concerning his origin, from which it appears that even savages are moved to speculate upon this problem. After this introduction comes a brief chapter on the geological history of the earth, the appearance of life, and the successive climatic changes in their relation to man. Then follow chapters on the Descent of Man, the Ice Age, Early Tools, and Early Types of Man.

The second volume, "Hunters and Artists," deals with paleolithic man, giving special attention to the geographical background, as the Retreat of the Ice; Changes in the Coast Line; Tundra, Steppe, and Forest. Then follows a sketch of paleolithic life, particularly well done, covering not only France but Spain and other outlying regions. One useful feature of this volume is the table of the most important skulls and stations, place of the find, a few of the outstanding anatomical features, etc., more than eighty in all. As usual, the volume closes with a chronological summary and the following interesting interpretation:

"Thus from a free and open hunting life the people of northwestern Europe had been reduced to the status of the poorest food-collectors . . . The closing in of the oak forest, completing the destruction of their hunting-grounds, was the main cause of this degeneration, and it seems likely that our predecessors would have remained for ever in this backward state, had not movements from the east brought a fresh impetus into their lives" (p. 150).

In fact, these few lines breathe the spirit of the whole work, the authors conceiving the human problem after the fashion of Thompson's "web of life" but extending the idea to include all changes, climatic as well as organic.

The third volume, "Peasants and Potters," is like the key to an arch—what preceded seems preparatory to it, and what follows is sustained by it. The ice ages were over, and the glacial wastes of Europe and Asia were covered with forests. The people, the authors believe, then settled down to a routine of food gathering, their only achievements being the taming of the dog and the acquisition of pottery; but otherwise the savage communities of Europe and northern Asia stagnated throughout this period. Yet in the valley of the Nile and the Fertile Crescent of the east the story was otherwise. Here one of the most significant developments was the raising of wheat and similar grains, regarded by the authors as the most important factor in the economic basis to the events to be heralded in the next volume. Closely linked with this is the development of pottery, the dairy, and the herds. The chief facts and problems connected with these developments are fully discussed. When we note that here appear in domestication the cow, goat, sheep, ass, horse, camel, and dog, we see how little remained for the world to add. It was, the authors think, this increased ability to feed himself, care for his children, and transport his equipment that accounts for the great advance. It is considered natural that these great achievements should influence the fringe of ruder peoples, especially on the north and west;

and we are shown the beginnings of what are to be great Mediterranean developments, culminating in Greece and in Rome. Mesopotamia and Egypt, however, are the great centers; and the chronological development of these centers is well worked out in a chart. At this time, also, the nations and peoples we still recognize are taking form, all of which is sketched in a few pages, followed by a chronological summary of the whole period. The point of view seems to be that civilization was the work of many communities. Not in Egypt alone, nor in Mesopotamia, are we to look for all that now makes up civilization; but by give and take, and with varying fortunes, thousands of communities scattered over a wide radius made this the joint contribution to the present.

"Priests and Kings" is the title chosen for the fourth volume, and for the most part the period dealt with lies at the dawn of history—3500 to 2500 B.C. We are told that this was "a remarkable millennium," marked by the unification that resulted in great empires in Egypt and Mesopotamia, with important developments in Crete, the Aegean, the Danube basin, and the fertile lands just north of the Black Sea; by the development of writing, stone and brick architecture, the use of metals, and an organized priesthood. Writing puts a different aspect upon chronology, since the record now gives us lists of kings and also an increasing number of dates. Another basic matter is that the climatic changes have been less, much less, giving a fairly stabilized epoch. It is not overlooked that local changes may have occurred to disturb the even rôle of culture, as not a few scholars assert; but the period as a whole seems to have been a kind of "hotbed" for the germination and propagation of cultures, for the organization of small tribal units into national bodies. The main section of the work deals with Sumer and Akkad, the old kingdom of Egypt, the Minoan, and the Aegean world. The development of metals is regarded as one of the outstanding achievements, if not the one great culture achievement; but agriculture and the sedentary arts were working their way into the valley of the Danube and what is now southern Russia, which the authors consider as laying the foundation to modern peasant life in Europe. The volume closes with a brief summary chapter on the races of man.

The series is well conceived, contains a wealth of fact, and will prove a useful set of handbooks for geographers, anthropologists, and historians.

CLARK WISSLER

THE HYDROGRAPHY OF THE NORTH AND BALTIC SEAS

Atlas für Temperatur, Salzgehalt und Dichte der Nordsee und Ostsee. 3 pp. of text, 48 pls. of maps and diagrs., bibliogr. Deutsche Seewarte, Hamburg, 1927. M. 15. 16 x 13 inches.

The North Sea and the Baltic wash the shores of some half dozen countries of northwestern Europe, each of which has carried out hydrographic work of various kinds in these waters. As a result, a considerable mass of information covering different areas is at hand. This information, however, is embodied in all sorts of publications and in a number of different languages. A comprehensive summary unifying this scattered information was much needed.

This feature gives especial value to the atlas of the Deutsche Seewarte. Of the 48 plates constituting the atlas the first is a chart on the scale of approximately 1:5,000,000 showing the depths in the North Sea, the Baltic, and their tributary arms. The following plates give the temperatures, salinities, and densities of these waters for the beginning of each of the months of February, May, August, and November. For each of these months charts on the scale of approximately 1:5,000,000 give the conditions at the surface and at the bottom, while smaller-scale charts represent the conditions at the 10-meter depth and at each 20-meter depth to 100 meters. There are also shown for each of these months the hydrographic conditions on four

principal profiles through these waters. Obviously the scale of the charts is too small to show the hydrographic conditions close to shore; and in the introductory remarks Prof. G. Schott and Dr. A. Schumacher, under whose direction the atlas was prepared, call attention to this.

For arriving at an understanding of the involved hydrographic features of the areas represented the atlas will fill a long-felt need. The notation "no observations" which appears in certain areas on a number of the charts directs attention to the need for such observations in these areas, and it is reasonable to expect that it will stimulate efforts in that direction. At the same time the atlas brings out the need for a discussion of the variations in the features represented—a desideratum which it is hoped may not long be wanting.

H. A. MARMER

CORRESPONDENCE

THE LABRADOR COAST

The *Geographical Review* for October, 1927, contains two very interesting articles on Labrador, "Notes on the Torngat Region of Northern Labrador," by Robert H. Woodworth, and "The Labrador Boundary Decision," by Sir Patrick T. McGrath, on which I should like to make some comments.

The first paper is an excellent and beautifully illustrated account of exploration in the Torngat region; but why should the accompanying map call the lake just inland from the end of Nachvak Fiord "Chance Lake"? On maps published by Daly and myself the same lake has the Eskimo name "Tessersoak"; and it seems better when possible to retain the native name. The name "Chance" might be given to a lake a few miles to the northwest, as shown on Woodworth's map.

Another point is in regard to the height of the Four Peaks north of Komaktorvik Fiord. I had a good view of that part of the Torngats from summits a few miles to the south and could not distinguish four special peaks rising above the rest. Instead there was a jumble of domes and peaks reaching about the same height. After a number of climbs near Komaktorvik and Nachvak fiords, one reaching 5500 feet, I very much doubt that any point in the Torngats reaches 6000 feet and feel certain that none rise to 7000 feet.

In Sir Patrick's paper attention is called to a matter which should interest all geographers, since the decision of the Judicial Committee of the Privy Council, the highest tribunal in the British Empire, includes a definition of the term "coast," or "coasts," which, it seems to me, is rather hard to accept. They decide that "coast" is equivalent to "watershed." In the particular case of the boundary between Newfoundland and Quebec the watershed is so placed as to include all the mountains of the region within the "coast." In fact the western edge of this "coast" is drawn far down the slope of the table-land toward Ungava Bay. The Torngats and other mountains toward the south have elevations running from 5500 feet to 2700 feet, while the inner edge of the "coast," according to the decision, runs only from 1750 feet toward the south of the watershed to less than 1000 feet toward the north at points inland from the Nachvak and Komaktorvik valleys. If this decision is to rule in geography very few countries will have any interior—they will consist solely of coasts.

The watershed in the heart of Labrador will make an extraordinarily troublesome boundary, since the parting of the waters on the peneplain is most intricate. Low, who made the only serviceable map of the region, speaking of the divide between Hamilton River and the St. Lawrence, says that "the watershed . . . is extremely sinuous and almost impossible to trace or define."[1]

[1] *Canada Geol. Survey, Ann. Rept.*, Vol. 8 (N. S.), 1895, subreport L, p. 129.

It is about the worst possible boundary and is certain to make trouble in the future. Low mapped iron-bearing Animikie rocks just on the Labrador watershed, and already two parties of Canadian prospectors have visited parts of the band, though without finding ore of workable grade. It is not improbable that deposits of gold or silver or copper will be found near the watershed, as they have been found in many other parts of the Archean Shield. If so, there will be a rush to the region by airplane and canoe, and this intangible boundary of muskegs and lakes and interlocking streamlets will suddenly become a matter of very lively controversy.

In practically unknown regions an astronomic boundary, whose position can always be exactly fixed, is much the best, such as the northern boundary between Alaska and Yukon Territory. In Labrador a boundary following the meridian of 63°, running north from latitude 52° to latitude 57°, then jogging west to longitude 65°, and finally north to the sea would have been far better. Perhaps, however, one would choose the highest Pleistocene beach, rising from 225 to about 500 feet above present sea level on different parts of the coast. This would run inland a few miles at all the bays and would provide the gently sloping or level ground for fish drying stages or summer dwellings and storehouses, which are all that the Newfoundland fisherman ever desired on the bleak Labrador coast.

I wish to call attention to another point. It is generally held that discovery and exploration of unoccupied territory give a valid claim to ownership; yet there is no mention in the Report of the Privy Council of the fact that, except for some excursions by American citizens in the region of Hamilton River and along the coast, the whole of the exploration and mapping of the region in dispute has been done by Canadian geologists and explorers. No Newfoundlander ever ventured far into the interior.

I am not aware whether this point was presented to their lordships; but from the wording of the report one may conclude that the decision was made on a purely legal view of the documents with no reference to practical considerations.

The map accompanying the Report of the Tribunal and showing the boundary is one of the worst published in recent years and is very incorrect in the northern portion with which I am familiar. For instance, Nachvak Fiord is shown as about eight miles wide instead of two, and Tessersoak Lake and Nachvak River are not indicated at all; while Komaktorvik Fiord, with its river and lake inland, is not even suggested. The two rivers flowing into these fiords, with their tributaries, will determine the boundary for more than fifty miles, and they are shown on maps published by the Geological Survey of Canada; but the cartographers for the Privy Council were not aware of their existence.

A. P. COLEMAN

Royal Ontario Museum
Toronto